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A FORECAST.

WITH the morrow commences the New Year, which, if political portents are to be relied upon, is fraught with forebodings of danger to the leading nations of Europe. Old Moore, of Almanac fame, is credited with the sage remark "if peace be not preserved, war is likely to ensue," a logical sequence which will hardly be disputed. What the effect of wars and rumours of wars will be upon the world's industries we do not pretend to say, but at all events it is not likely to lead to immediate progress; this is all the more to be regretted, when new and important ventures in the most recently developed industry are ready to be launched upon the ocean of commerce.

Perhaps, however, when every nation is up in arms and doubting the honesty of each other's intentions, this very readiness to appeal to force may be the means of preserving peace. Assuming that the political horizon will clear itself again, what will the next twelve months bring forth in the electrical world?

Electric lighting has held the foremost place amongst electrical industries for the past six years, but is it not time that it should vacate this position in favour of the electric transmission of power, or electric locomotion? By this we do not mean that the popularity of the electric light is on the wane. Rather the contrary; but we do consider that at the present moment electric locomotion has stronger claims upon the financial public. We have several means of effecting transport from one place to another, but it stands to reason that if a cheaper, more convenient, and more easily managed system of conveyance than any at present existing is ready to hand it must eventually be adopted.

Electric locomotion has recently been shown to be not only practicable but much less costly than horse-traction, and the Electric Locomotive and Power Company is prepared to start a number of cars on the North Metropolitan Tramway Company's system immediately upon receipt of legislative sanction. It is also gratifying to see that a company has at length been organised to carry on the system so successfully introduced at Blackpool by Mr. Holroyd Smith. Much is being accomplished in the United States in the same direction, and we look forward with confidence to a great development of the electrical propulsion of vehicles in both countries during the ensuing year.

It also appears tolerably certain that considerable activity will be displayed in the search for a submarine boat which shall realise the anticipations of M. Jules Verne, in his exciting romance, "Twenty Thousand Leagues under the Sea." The famous vessel, the outcome of the prolific French author's vivid imagination, and in which Captain Nemo took his extraordinary voyages, does not seem to be so far from being a *fait accompli* as it was at the time of its introduction to the novel-reading public, and electricity is destined to play a great part in both propelling and manœuvring these interesting traversers of the deep.

Electric lighting, although not progressing rapidly, is making good strides, notwithstanding the fact that little or no chance has as yet presented itself of producing the electric supply more cheaply. What is now required is not so much improvements in dynamos or lamps, unless when threatened by a monopoly, as a less costly fuel. We believe that some time ago Mr. Miller, of Glasgow, used petroleum for producing his steam-power; but we have never heard the result of his experiments. Would it not be worth while, in view of the "coming inundation of Russian petroleum," to further investigate the claims of this oil as a fuel?

The electric lighting of railway carriages is a matter which is not likely to be overlooked, and there are signs already to indicate that considerable vitality may be expected in this department of applied electricity.

But perhaps the greatest development of all will be found in the manufacture of secondary batteries. These apparatus are now recognised as having passed the doubtful stage of their existence, and with careful attention, may be expected to perform their duty for several years without renewal; their functions are practically boundless, for they are suitable for purposes connected with almost all the applications of electricity.

Telegraphy as an art has, perhaps, almost reached its limits, but the time has arrived when some scheme should be forthcoming for the placing of electrical conductors underground, not because danger to the public need be apprehended, but because such storms as we have experienced this week so seriously interrupt telegraphic and telephonic communication as to cause the gravest anxiety for the future.

It is, perhaps, too much to expect any great activity in telephony, although the action of the New Telephone Company may, indeed, render the monopoly which has hitherto been such an incubus upon telephonic extension less rigorous.

The electrical transmission of power, so far as the supply of motive power to small workshops is concerned, is a matter to be dwelt upon in the distant future, although applications of a limited nature may be continually made.

All things considered, we do not think we shall be far wrong in saying, now that trade is reviving, that all along the electrical field a steady increase in activity will be observable during the next twelve months, more especially for those firms which have become firmly established. The high rate of discount in the money market may not be calculated to foster the flotation of new companies, but this is to the advantage of those in possession of the field, and electrical engineers can congratulate themselves that the prospects before them are by no means of a discouraging character.

RECENT ADVANCES AND IMPROVEMENTS IN THE APPLICATION OF ELECTRICITY TO RAILWAY WORKING.

TYER'S TRAIN TABLET SYSTEM.

THE object of this invention is to facilitate the working of trains on single lines of railway. Single lines have hitherto been worked by time table and telegraph, *i.e.*, where the running has been out of course and it has been necessary in consequence to alter the point at which a train should cross another train proceeding in an opposite direction, instructions are telegraphed to the stations concerned to that effect. Of later years it has been customary to establish upon all lines, carrying a passenger traffic, a system of electric block in conjunction with the "train staff." By train staff is meant a staff of metal or wood peculiarly shaped, each shape being applicable to one section of line, so that it may not only be recognised by the inscription which it bears, but by its shape as well. Without this staff no train is allowed to proceed. It will be clear that, this rule being adhered to, no system can be safer; for so long as there is but one staff, and that staff in use, no other than *the one* train can be upon the one section of line.

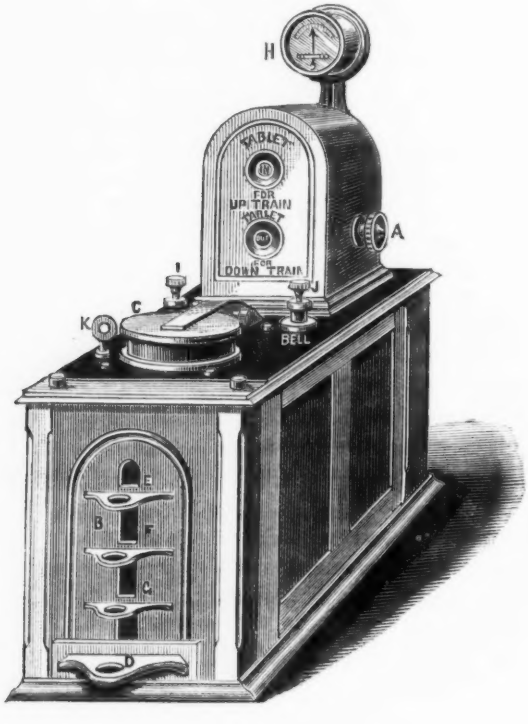


FIG. 1.

The system, however, has its inconveniences. If the staff is at B when you require it for any special purpose at A, you are helpless until you obtain it by some means from B. It is just this inconvenience which Mr. Tyer in his tablet system seeks to obviate.

To this end he replaces the staff by a tablet, and he so arranges his apparatus that only one tablet for any one section of line shall be obtainable or absent from the two sets of instruments which comprise the section of line. Thus A, having obtained a tablet, may send a train with it to B, but instead of B being obliged to return it to A for a following train, B has merely to place it in the instrument at that point communicating with A, when A can obtain from his instrument another tablet, and with it send on his following train; but he can only do this when the tablet obtained for the conduct of the first train has been restored to the instrument at B.

We give herewith an illustration of the instrument, which, together with a bell or gong, constitutes the apparatus for one end of a section, or for a terminal station.

The principle upon which the system is based is that no tablet shall be issued from station A without the consent and co-operation of station B; and that when once a station has issued a tablet no other tablet can be obtained for that section until that issued has been delivered up at its destination and deposited in that portion of the apparatus provided for its reception.

The apparatus is constructed in two portions, viz., an indicating instrument and a receiving instrument (fig. 1). The former has two discs carrying the inscription "in," "out." The upper disc is operated by the current from the distant station; the lower disc is moved mechanically by means of the large knob, A, seen on the right of the instrument. The two discs are arranged to interlock the one with the other, and cannot be made to show contrary signals. Thus, if the section of line between the two signal posts is clear, both discs will indicate "train tablet in." When the down train disc is turned to "train tablet out," the up train disc becomes locked, and cannot be operated upon; and, in like manner, when the up train disc is required to show "train tablet out," the down train disc will become locked.

The receiving instrument consists essentially of a cylinder, B, provided for the reception of a series of circular metal train tablets. These tablets are inscribed with the section of line to which they are applicable, and are numbered in consecutive order. C is a lid covering a shallow pan fitted to the upper portion of the cylinder. This pan is hinged to the lid, and so arranged that when the lid is opened the pan is fixed for the reception of the tablet, and when the lid

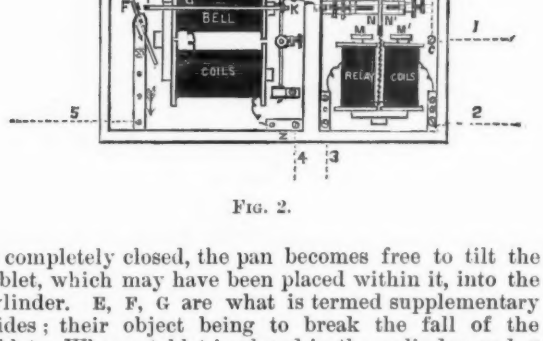


FIG. 2.

is completely closed, the pan becomes free to tilt the tablet, which may have been placed within it, into the cylinder. E, F, G are what is termed supplementary slides; their object being to break the fall of the tablet. When a tablet is placed in the cylinder and C is closed, it falls to the level of E; E is withdrawn, and it then falls to F, and so on; D being the sliding plate, provided with a recess in its centre, from which on drawing it out—of course, after the necessary permission to do so has been obtained from the distant station—the tablet is obtained. This sliding plate is retained in one of its two positions, either out or in (as may be required) by means of double racks and pawls, the pawls being operated upon by an electro-magnet and polarised armature, in connection with the receiving portion of the apparatus.

In order to understand the action of the instrument as a whole, it will be necessary to dissect it and deal with it in its several parts.

We will deal in the first place with the *bell and relay*. This consists of two parts, the relay electro-magnet which is connected with the line wire, and the bell electro-magnet connected with the local circuit. M, M', fig. 2, are the poles of the relay magnet. Between these poles hangs a small magnet, L, which is polarised by a strong permanent magnet at the back of the case. The magnet, I, is retained in a position midway between M, M', or between the adjusting screws, N, N', by a helical spring, but is free to move to either side under the influence of any current which may pass through

the coils, according to its direction, whether positive or negative.

The terminal, C, is in connection with the carbon pole of the local battery, and the terminal, Z, with the zinc. Following out the connections of the figure, it will be obvious that on any current passing through the relay coils, the bell coils will be actuated by the local battery, and the bell will be sounded. The magnet, L, is provided at P with a small stud, and to the left of L is seen an insulated spring, S. This spring is connected with the bedplate of the bell coils by a strap, S', by which it obtains connection with a steel rod, G, hinged at K to the bell armature, and tipped with platinum at T. Opposite T, and hanging vertically on a horizontal axis, is a small fan, F, from the support of which is a connection to the commutator locking coils of the tablet apparatus, and ultimately to the zinc pole of the local battery. Here, again, it is evident that whenever P makes contact with S, and T contact with F, the local circuit through the said commutator locking coils will be complete. Now P is in all cases attracted towards S when the relay coils are traversed by a positive current. Let us see what this positive current does so far as this portion of the apparatus is concerned.

P is placed in contact with N, and a portion of the local current circulates through the bell coils, actuating their armature and sounding the bell. Then P forms contact with S, and the other portion of the local currents passes to K along G, and strikes F, and so on to the commutator locking coils. But F being free is driven away from T, and the contact being extremely momentary it fails to influence the commutator locking coils. Hence, so long as the ordinary beats are given on the bell, this divided local action is practically incomplete, but when the bell "plunger" at the distant station is held down, thus transmitting a continuous current, T is not only forced forward towards F, but retained there, and F, after swinging away on the first impact, returns to and rests in contact with T, and when this is so a portion of the current does pass through and operate the commutator locking coils. It will be seen further on when we look into the action of the apparatus as a whole, that this holding down of the plunger constitutes one of the most important duties of the signalman in operating the instrument.

(*To be continued.*)

WOODHOUSE AND RAWSON'S SWITCHBOARDS.

No electric light installation can be complete without the means of measuring the current and the E.M.F. of the circuit and the distribution.

In simple series arc light circuits, the only apparatus generally necessary is an ammeter, by which the value of the current is indicated; a voltmeter showing the number of lamps in series, and a switch for making and breaking the circuit; and even these are frequently dispensed with.

In installations consisting of a number of incandescent or other lamps in parallel, where there are frequently a number of main branch circuits, it is almost imperative to have properly devised methods of controlling the system; the apparatus being conveniently placed in or near the engine room.

The economical arrangement of an installation must largely depend on the nature of the place to be lighted, and consequently switchboards have to be designed to meet the requirements of every probable case.

The Woodhouse and Rawson Electric Manufacturing Company has had exceptional experience in the construction of switchboards, and we give below a brief description of the forms that have been more prominently brought into use. We may state here that the switchboards made by this company generally have slate or mahogany fronts, and that the connections, which are made of copper strips rivetted and soldered together, are carefully protected and covered in at the back of the switchboard. Every switch and instrument can be independently removed without any trouble or disturbance of the connections, so that any damage to part of the controlling apparatus is easily set right. The company generally fits its own well-known switches, indicating instruments, cut-outs, &c., on to the switchboards, but other apparatus can be adapted.

The first type, "A," mentioned in the price list sent us is a very simple board, having a switch, a Cunynghame, Woodhouse and Rawson magnetic cut-out, an ammeter and a voltmeter, and is intended to control a single circuit.

Types "B" and "C" are provided with connections for a set of accumulators and have magnetic cut-outs to both the dynamo and lamp circuits; a two-way switch allows the current passing in the line, dynamo, or accumulator circuit to be measured on one ammeter, and a voltmeter is also provided.

The latter type of board has also an accumulator regulating switch for varying the number of cells, and a switch for adjusting the resistance in the field-magnet circuit of the dynamo, the E.M.F. of which is thus kept constant even when the speed varies.

The "D" type is the one particularly recommended for ordinary installations. Besides having all the advantages of the "B" and "C" switchboards, it has a two-way switch by which the lamps, &c., can be supplied with current at the proper E.M.F. from the dynamo and accumulators when the former is charging the whole of the cells. This arrangement is particularly useful where it is necessary to leave a few lamps burning during the day time, when under ordinary circumstances the dynamo is charging the cells for the night's work. The E.M.F. at the terminals of either the dynamo or the line can be ascertained from one voltmeter by means of a two-way switch. This switchboard therefore allows current to be supplied to the lamps from the dynamo alone or the accumulators alone, or from both coupled together in parallel, in every case having exactly the right E.M.F., which is a very important matter for the life of the lamps. This type also can be arranged to control any number of dynamos, any one or more of which may be simultaneously brought into action by simply moving a switch.

The next type in the list is called "J"; it has a two-way switch to each dynamo connected to the board and a number of branch line switches with a magnetic cut-out or safety fuse to each; a voltmeter and ammeter are also provided.

The "L" type controls an installation in which there are several dynamos and line circuits, and allows any one of the dynamos to be connected to any one or all the lines, while each line can only be in circuit with one of the dynamos at a time. Magnetic cut-outs and measuring instruments are provided as before.

Type "N" is a newer arrangement particularly suitable for large installations, where it may be desired to charge accumulators from one dynamo while others are independently supplying current to the lamps, &c. To each machine on the installation, there is a three-way switch which allows the dynamos to be put direct to line or lamp circuit or through an ammeter to line; or to a separate line which simply allows the dynamo to charge the accumulators. This latter line has an ammeter, cut-out, and accumulator regulating switch, and can be connected by a switch to the line proper which also has the usual measuring and safety apparatus.

A switchboard called "Z" type is arranged to work an installation on the three wire system. The current to each set of lamps passes through an ammeter and cut-out; and by means of two two-way switches either dynamo may be immediately used to supply current to both sets of lamps. This last point is particularly important, as in the case of an accident to one of the dynamos, the whole set of lamps might otherwise be useless.

In addition to the above we notice branch line switchboards consisting of Woodhouse and Rawson's patent sliding switches. These are particularly applicable where it is necessary to subdivide the main

current, and the form of the switch admits of a large number of lines being controlled by one small board. These switches are already well known, so that it is perhaps hardly necessary to say that they consist of flat brass bars (or in another form of tubes) sliding in guides and carrying at one end a split spring which is forced into a jaw, where it makes perfect contact, when it is desired to complete the circuit. The other end of the sliding bar carries a handle, and any number of these switches can be placed compactly side by side on the board.

It may be particularly pointed out that the successful working of an installation, and the freedom from accidents, must largely depend upon the care which has been bestowed upon the switching and safety devices, and it will be admitted that Messrs. Woodhouse and Rawson have apparently provided for every contingency. Switches are provided and conveniently arranged for all changes that can be required, no loose connections being anywhere allowed; each circuit has a Cunynghame, Woodhouse and Rawson magnetic cut-out in it, which, in itself is almost a perfect guarantee against accidents; all switches, &c., are labelled so that no mistake may occur, though if such a thing were to happen, the arrangements are such that no harm could result; and the workmanship and finish are all that can be desired. We understand that the company usually manufactures these various types of switchboards in four sizes to carry respectively 50, 100, 200, and 500 ampères.

A RELATION BETWEEN MAGNETISING FORCE AND CORE OF MAGNET.*

By E. L. FRENCH.

THE following account of an experiment, carried on by me at the Physical Laboratory of Cornell University, may prove interesting to some readers.

It has seemed to me that a formula which would enable a man to state the greatest number of ampère turns that could be used economically on a core of given size, might have some practical value. By "economical" use, I mean that the strength of the magnet increases rapidly per ampère, up to this

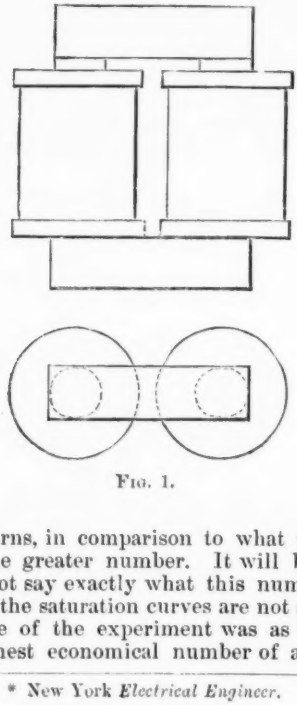


FIG. 1.

number of turns, in comparison to what the increase is with a little greater number. It will be seen later that we cannot say exactly what this number is, since the bends in the saturation curves are not sharp ones.

The scheme of the experiment was as follows: To find the highest economical number of ampère turns for each of several electro magnets, all of same type and material, and having cores whose diameters increase regularly by a small amount. To decide what was the highest economical current for each magnet (the turns being constant), by plotting a curve whose ordinates are proportional to strength of magnet, and abscissæ are proportional to ampères of current. Finally to take these "highest economical currents" in ampères, and their corresponding diameter of core in centimetres, and plot them for a final curve. The equation of this last curve will furnish a formula which gives us the diameter of core, when ampére turns are known, or gives the ampere turns when the diameter is known —provided the material and type is the same as in those magnets experimented upon. The type of magnet used is shown in fig. 1, which gives plan and elevation. The cores are of circular cross section, and the armatures of square. Each edge of the cross section of armature equals the diameter of its corresponding core. Five such cores, with their armatures, were made from patent cold-rolled shafting, presented to the University by Jones and Laughlins, of Pittsburg, Pa., and used in a set of spools which would just admit of the largest core, as will be seen by the table of dimensions below :—

SPOOLS.

Internal diameter of tube.	Thickness of tube (brass.)	Wire.	No. turns on each spool.
6·34 cm.	About 2 cm.	No. 10 copper wire, single wound, run through paraffin.	785

CORES.		ARMATURE.	
Diameter.	Length.	Section.	Length.
1·22 cm.	20·85 cm.	1·22 × 1·22 cm.	18·3 cm.
1·22	20·85	1·22 × 1·22	18·3
2·52	20·88	2·52 × 2·46	19·62
2·52	20·88	2·54 × 2·46	19·62
3·76	20·82	3·80 × 3·74	20·90
3·76	20·82	3·80 × 3·74	20·90
5·03	20·82	5·10 × 5·02	22·04
5·03	20·82	5·10 × 5·02	22·04
6·34	20·88	6·32 × 6·30	23·90
6·34	20·88	6·36 × 6·30	23·92

Armatures of section 2·52 × 2·46 and 2·54 × 2·46 were steel, Jones and Laughlins not having the cold-rolled shafting on hand. The extreme length of the spools was about 1 centimetre less than the length of cores, to admit placing a narrow coil of fine wire close around the pole above the spool. The surfaces of the armatures were planed smooth and the ends of cores squared off (in a lathe) at the Sibley college shops.

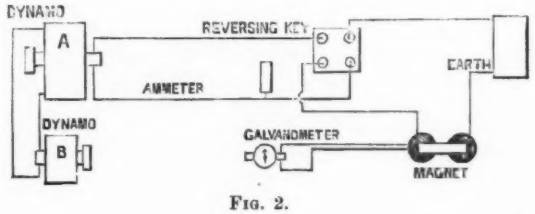


FIG. 2.

In all tests made by me, the magnets were set up as shown in fig. 1. In making experiments on the magnets, to determine the highest economical number of ampère turns, the connections were made as shown in fig. 2. The current was furnished by a Gramme dynamo, A, which had its magnets magnetised by a small Weston, B. A Siemens and Halske electro-dynamometer was used to measure the larger currents, and a Thomson ammeter for the smaller ones. The galvanometer was a heavy astatic one. The ammeter

* New York *Electrical Engineer*.

was placed near the reversing key, and the galvanometer was on the farthest side of the same room. The magnet was placed in a distant part of the laboratory, while the dynamos were still farther away. The narrow coil of fine wire placed close around the pole was in circuit with the galvanometer.

Now, a reversal of the magnet poles, by reversing the current through the magnet, causes a deflection of the galvanometer, since an induced current is generated in the narrow coil at the instant of reversing. The sine of the half-angle of deflection is proportional to the strength of the magnet. In my experiments the angle was small, and I have used the double deflections—*i.e.*, the difference of the right and left deflections as read from scale.

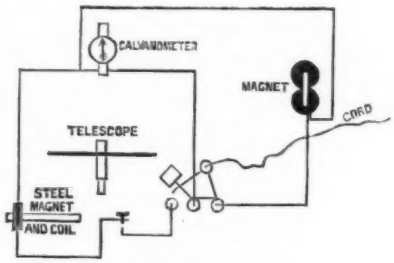


FIG. 3.

The induced circuit was always broken except at time of reversals and till the galvanometer reading was taken. This prevented, to a great extent, any disturbance of the galvanometer by fluctuations of current from the dynamo. It was convenient to place the key for closing the induced circuit upon the table that supported the telescope and scale for reading the galvanometer; hence a peculiar form of key was made that could be closed by pulling a cord, while standing at the other side of the room near the reversing key and ammeter.

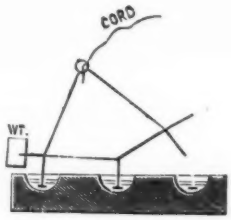


FIG. 4.

Let us suppose the dynamos running, and the ammeter indicating a steady current; also the galvanometer at rest. I stand by the reversing key, note the reading of the ammeter, close the induced circuit (by means of the cord), reverse the current, and step quickly across the room to read the first swing of the galvanometer.

Four such reversals were made with each current, and the mean of the two double deflections used. Thus we have strength of current, and a number proportional to strength of magnet. The saturation curves for the different magnets are shown in fig. 5.

To determine what the highest economical current is for a magnet, I drew a line coinciding with the rapid rise of the saturation curve, and another with the nearly horizontal part of it, and produced them till they intersected. I then bisected the angle thus formed. This bisecting line cuts the curve at a point midway between greatest economy and greatest waste of current. This method gives similar points in each curve. Ordinates of points thus determined are given below, opposite their corresponding diameter of core.

Current.	Diameter core.
·35 am.	1·22 cm.
·55	2·52
·83	3·76
1·37	5·03
1·52	6·34

Plotting currents as abscissæ, and diameters as ordinates, we have the "final curve," also shown in figure 5. The equation of this curve is $y = 8{\cdot}8868\ x^4 - 25{\cdot}80116\ x^3 + 22{\cdot}07239\ x^2 - {\cdot}93553\ x - {\cdot}22125$; but the following simpler equations give close results, when values of x from the above table are substituted, $y = 9\ x^4 - 26\ x^3 + 22\ x^2 - {\cdot}7\ x - {\cdot}22$.

If we substitute for x ·83 (see table) we have 3·76 cm. for the diameter of core, which would be brought up to greatest economical strength by ·83 x 1570 ampère turns. Again, if we substitute a value for y and solve for x, we must multiply the value of x by 1570 (the number of turns on spools) to get the ampère turns.

Fig. 3 shows more fully the connections with galvanometer at time of reversal. Fig. 4 is a larger view of key for closing induced circuit.

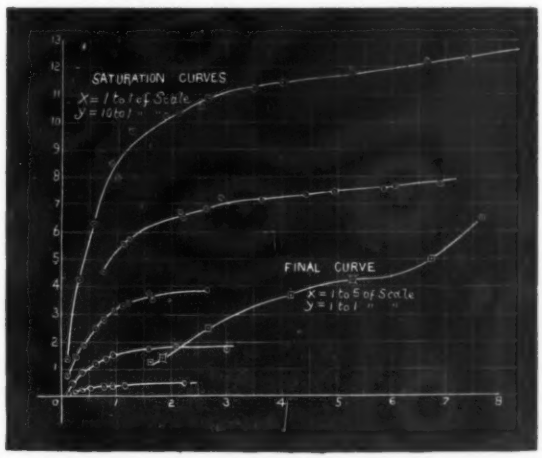


FIG. 5.

When the experiment was begun, I intended also to use for the smallest two cores a set of smaller spools of No. 14 wire, with same number of turns as the larger, to see if a different "highest economical current" would be obtained. Also to make tests of magnets with one armature off, and also to test a magnet with differently prepared surfaces of contact between armature and core. These experiments were omitted for want of time. It will be seen that the method of reversals is that of Prof. Rowland.

ABSOLUTE ELECTRO-DYNAMOMETER.*

Note by M. H. PELLAT, presented by M. LIPPMANN.

THIS apparatus is a balance electro-dynamometer, which enables the intensity of a current to be obtained directly and correct within $\frac{1}{2000}$. This instrument has been constructed by M. Carpentier, and may be described as follows:—

The electro-dynamometer consists of two concentric bobbins; one is long and has its axis horizontal, the other, which is smaller, is contained inside the first, and has a vertical axis; the same current passes into both bobbins. The small bobbin being thus placed in the almost uniform magnetic field, produced by the larger one, is subjected to a couple which tends to make its axis deviate from the vertical; it is by the

* *Comptes Rendus.*

measurement of this couple that the intensity of the current is obtained. To effect this the small bobbin is connected with the beam of a balance which has at its extremity a scale pan suspended in the ordinary manner. The two knife-edges and their bearings are of agate, there being no steel in the apparatus at all. Two very fine silver wires, forming two turns of a spiral, opposite the knife-edge on which the beam rests, enable the current to pass into the little bobbin without impeding the movement of the beam. By placing weights in the scale pan we make equilibrium with the electro-dynamic force.

The intensity of current is thus given in units of C.G.S. by the formula

$$i = \sqrt{\frac{g\,l\,e}{\pi^2\,d^2\,\text{N}\,n\,(1-a)}}\sqrt{p},$$

in which p represents the mass in grammes placed in the scale pan, g the coefficient of terrestrial acceleration, l the distance of the angles of the two knife-edges (about 0·30 metres), d the diameter (about 0·11 metres) of the axis of the spirals of the single layer of wire that the little bobbin bears, n the number of these spirals (164), N the number of layers (10) in the large bobbin, e the distance of the axes of two consecutive spirals of this bobbin (about 0·13 centimetres); finally, a is a correction which depends on the ends of the large bobbin, and which would be 0 if the bobbin were endless, and which is obtained with great accuracy by calculation.

The measurements of l and d have been made by the International Office of Weights and Measures, that of e by myself, but it has been reduced to the international metre. Thus the coefficient of $\sqrt{p}$ is known to within $\frac{1}{2000}$. A current of 0·3 ampères is counterbalanced at Paris by 0·4180 grammes; the balance being sensitive to $\frac{1}{20}$th of a milligramme. This apparatus has the advantage of placing the ends of the bobbin bearing several layers far from the other bobbin; the error arising from the inevitable irregularity of winding at the ends in passing from one layer to the next is thus rendered insignificant. Moreover, by a displacement of the large bobbin according to its axis, it allows us to make sure that no material error has entered into the somewhat long calculation that gives a.

I propose to use this instrument:—

(1.) To determine absolutely the electromotive force of batteries (E = I R).

(2.) To determine the ratio of the electro-magnetic and electro-static units by measuring the same electromotive forces with an absolute electrometer.

(3.) To determine the mechanical equivalent of heat; the work I^2 R T, converted into heat in a very fine wire immersed in a calorimeter, can thus be known to within $\frac{1}{4500}$.

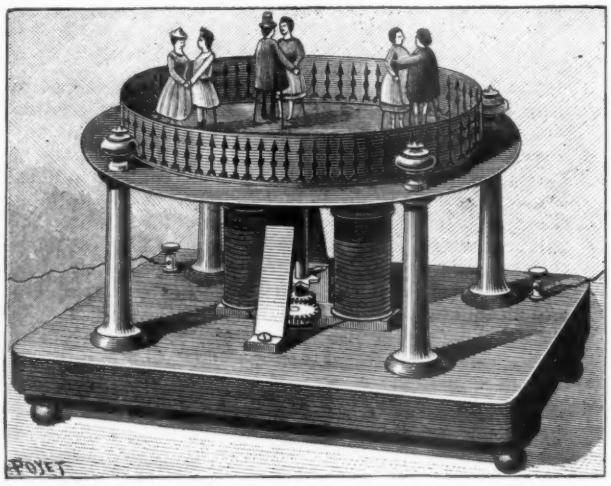
We shall shortly give a detailed description of the electro-dynamometer, the precautions that have been taken in the exact measurement of its elements, the calculation of the term a, as well as the results of the experiments already mentioned, which are now proceeding.

SCIENTIFIC TOYS.

THE ELECTRICAL WALTZERS.

THE apparatus shown below, on which we see little figures gyrating on horse-hair supports, consists of three principal parts: (1) a platform of smooth sheet iron, fixed on pillars, and on this the little waltzers are placed; (2) an electric motor; (3) a musical box (?) worked by the motor. The latter consists simply of an electro-magnet, between the poles of which revolves a flywheel with projections of iron; on the axle of this wheel is mounted a contact wheel, the circumference of which is indented with teeth equal in number to those of the projections on the flywheel. On this wheel a commutation spring presses, which at every contact with the teeth of the contact wheel introduces a battery current into the electro-magnet, the poles of which become magnetised and attract one of the projections on the flywheel which begins to turn: when they are brought opposite the poles of the electro-magnet the commutating spring falls into a hollow between the teeth of the contact wheel, the current is interrupted, the electro-magnet is demagnetised and allows of the passage of the projection of the flywheel which continues to turn by the speed acquired, and brings the contact wheel into fresh contact with the commutating spring. The attractive function of the electro-magnet is renewed, and the flywheel is kept turning in the same direction by the successive effects of attraction and acquired speed. A pinion on the axle of the flywheel communicates its movement to a wheel working the musical apparatus. The electro-magnet is arranged vertically, and its poles are prolonged beyond the bobbins and at a little distance from the horizontal platform.

As we see, up to now the motor has no other function than to work the musical box; but where the apparatus becomes ingenious, is in the application of the principles of action of the motor to the actuating by influence of the little figures. We say by influence, for the platform on which they dance has no contact



with the motor, and receives no movement from any part of it. In fact, referring to the working of the motor, we observe that the electro-magnet is alternately magnetised and demagnetised in quick succession, and as its poles are near the centre of the platform, the latter vibrates like a telephone membrane. Seeing that the waltzers are only little figures mounted on horse-hair, and that the surface of the platform is rough, we can easily understand their movements, which seems to keep time with the music, and the illusion is all the more perfect owing to the fact that the same cause produces both effects.

In order to work this little toy, bottle bichromate of potash batteries may be used with advantage. The facility with which the current may be modified enables the figures to turn with more or less rapidity. With two elements in series a good result is obtained.

The vibrating membrane may be stretched or relaxed at will by means of two screws placed in the middle of its surface; if the movements should be too violent, so as to overturn the figures, the speed may easily be regulated.

This toy, constructed by M. Bassée-Crosse, is as charming as it is ingenious, and the electrical waltzers always prove a great attraction to juvenile spectators. This apparatus may at the same time afford instruction, and this is the double object that should be aimed at in devising every really scientific toy.—*La Nature.*

GILBERT'S IMPROVED METHOD OF BINDING WIRES TO INSULATORS.

THIS method of binding, the invention of Mr. A. E. Gilbert, telegraph superintendent of the Highland Railway Company, is stated by the inventor to be more durable than the ordinary method, and to improve the insulation of the wire.

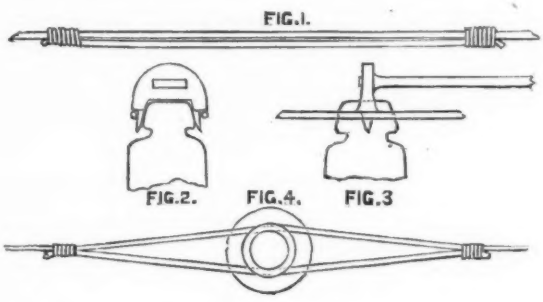


Fig. 1 represents the line wire with the improved binder attached to it; this binder is of the same gauge as the line wire, and is bound with ordinary binding wire (soldered) at its ends as shown. The loop thus formed is opened out by a special lever tool which will be understood from figs. 2 and 3, and then slipped over the insulator and the tool withdrawn; the wire then remains fixed on the insulator as shown by fig. 4.

ELECTRIC LOCOMOTION.

IT was gratifying to learn from the pages of the REVIEW for the 17th inst. that the subject of electric locomotion is making some little stir in commercial circles. I refer, of course, to the company just registered for the acquisition of the patents which cover the system of Mr. Holroyd Smith, whose Blackpool experience has doubtless made capitalists think that something may be done to turn an honest penny by embarking in a speculation which is entirely new to them.

It is to be hoped that the result of the venture may justify the faith which has been awakened in the evident economy attached to propelling tramcars electrically in lieu of employing horse flesh, and that the company, the first in the field to be formed to operate with underground conductors, may be but the forerunner of many yet to come.

In asking leave to make a suggestion in your pages my object is not to enter into the financial details of electric locomotion, but to offer a few remarks which have occurred to me on the methods of propulsion.

A perusal of the REVIEW from week to week is sufficient to indicate that overhead conductors, underground conductors, and the self-contained accumulator system have each their adherents, and that much can be said for and against any particular method. It is, however, questionable whether the conductor system, overhead or underground, can be successfully operated in the face of Parliamentary regulations as to E.M.F., technical objections to high tension, costs of mains, waste from heating and leakage, and heavy working expenses where water power is not available, beyond distances which may be termed comparatively short. On the other hand, can accumulators be made to do more when we consider the dead weight which must be carried in the cars, the loss in electrical conversion, and the high rate at which they are made to discharge?

It appears to me that both systems, to be commercially successful, must be very limited as regards the distances worked over, but it has occurred to me that a combination of the two might be so arranged as to greatly increase the range of operations and at the same time keep down the working cost to a minimum.

If I am not mistaken the plan for lighting Colchester by electricity was based upon the following operations:—Secondary batteries were established in cellars in various parts of the town, and these were charged in series from a central station. When sufficiently charged they were automatically cut out of the main and placed in the lighting circuit. I would suggest that a method analogous to this might advantageously be employed for electrically propelling cars on tramways. At stated intervals along the line, say at distances of one mile apart, secondary batteries might be installed in any convenient and available situation which could assuredly be found without difficulty, and charged from a central station. The conductors should also be made in sections each a mile in length, each section depending upon its respective set of accumulators for the supply of current. Arrangements could of course readily be devised, so that while one set was discharging over its own section of line, the rest should continue charging until it came to their turn to discharge, and when this was over *pro tem.*, be thrown into the charging circuit again. The charging conductors would be of small sectional area, the distance over which they could extend is practically unlimited so far as ordinary tramways go, and each section of car conductor might be made according to the state of the road. Thus, if any given section contained steep gradients or sharp curves, the conductor, and also its secondary batteries, must be so proportioned as to meet the requirements of the work; heavy work, large conductors, and plenty of battery power; little work, small conductors, and a correspondingly small number of cells.

It is very certain that although losses would occur in conversion, a considerable saving could be effected in heat waste and leakage from the car conductors, and it simply becomes a question of calculation which I must leave to others to decide, whether the method I have here suggested is meritorious and worthy of consideration. So far as novelty is concerned, I have never seen a similar project broached either in this country or in America. It also suggests itself that dynamos placed along the line with their field magnets excited from the central station or continuous current transformers, would answer the purpose; but my desire has already been accomplished, and I leave any further discussion to those of your readers who may feel sufficiently interested therein. Mr. Holroyd Smith and Mr. Reckenzaun could doubtless quickly decide whether such a method of working is ever likely to meet with adoption under particular circumstances.

MUSICUS.

PRIORITY OF INCANDESCENCE LAMPS.

M. EMILE PICARD, addressing the President of the Belgian Society of Electricians, from Brussels, says:—"I have duly received No. 7 of the *Bulletin de la Société Belge d' Electriciens*, containing a letter from M. Somzée,* a discussion of my reply to M. Evrard's lecture, and a comparative table of the Somzée and Edison patents, all by the same author.

"I will reply point by point to the letter, which will enable me to dispense with a notice of the other documents. I will make merely one observation: to wit, that for the requirements of his case, M. Somzée has strangely modified the terms of his patent; these changes occur in all his citations, and are, therefore, intentional, and what seems to be the climax, is, that in a pamphlet which I have just received, entitled, 'Priority of the Incandescence Lamp.—The Somzée—Edison Case' (Société Belge d' Electriciens) Bulletin for April, 1886, the author introduces these same changes into my own quotations, and thus makes me say something different from what I have really said. I will return, moreover, to this strange manner of discussion, which consists in substituting for expressions used, others of a different meaning, and taking his stand upon these inexact expressions to uphold a line of argument.

* See the ELECTRICAL REVIEW for October 1st, 1886.

"A cause which can only be defended by such a system of falsification is condemned beforehand, and my whole reply might be confined to this disclosure. But, nevertheless, I am willing to continue the discussion, and following the course of M. Somzée's letter, I will point out all the errors and inaccuracies therein contained. This will be rather long, since the errors and inaccuracies are numerous, but it will, I hope, put an end to this futile discussion which no longer interests anyone.

"M. Somzée's letter completely changes the original nature of the debate. I have pointed out as inaccurate the following conclusion of M. Evrard's lecture :—'If we compare the dates of the Edison and the Somzée patents, we find ourselves confronted by an indisputable fact, namely, that prior to Edison's Belgian patent, M. Somzée had given a complete programme of the conditions which a glow-lamp must fulfil ; he has given the principal arrangements and a complete drawing. . . . . The Somzée lamp is characterised by :

"1. The use of a very pure and very dense carbon.

"2. Filament bent in the form of a horse-shoe, with a smaller section at the curve than at the shanks.

"3. Carbon removed from every oxidation or deterioration.

"4. Thermic regulator.

"I have, I think, demonstrated clearly that all this was in existence prior to the Somzée patent ; that not only had this been described in several patents, but that even the exact design is to be found in an earlier patent of Edison's.

"At present, M. Somzée abandons all these practical conditions of glow-lamps, and in place of seeking to refute my observations, he plays upon words. I might very well confine myself to the reply which I have made, but I am willing to follow M. Somzée over all the grounds which he has chosen, and discuss with him words as well as ideas. Nevertheless, since it is a question of words, I will admit only those which are found in the patent and not the ingenious substitutions which M. Somzée has thought fit to introduce to suit the requirements of his cause.

"I thank M. Somzée for the praises which he lavishes upon me, but which, unfortunately, are misleading. I am not and have never been, Edison's agent, and I have not been commissioned by him, or by anyone, to defend his glow-lamp against the attacks of which it is the object. It is, therefore, incorrect that it is as Edison's agent that I have pointed out the inaccuracies of Evrard's lecture. We may, therefore, dismiss 'M. Picard's interests, his skilful tactics, his work as an excellent patent-agent occupied with means for shielding his client.' These are unfounded phrases and insinuations, and it results that the only person interested in this affair is M. Somzée himself, who believing that he has created a novelty has merely reproduced something known long ago.

"M. Somzée proposes, as he tells us, to signalise the principal errors of my communication, and, what is here characteristic is that he founds his entire argument upon manifest errors. I have pointed out the first, and I am about to bring forward the remainder, one by one, following the order of M. Somzée's letter.

"M. Somzée says of the hydrothermic regulator, that it is indicated as the means to be employed *only* in case we still wish to have recourse to metallic spirals.

"This is a second error ; for I have just re-read M. Somzee's specification. The object of the patent is : 'An apparatus for giving warning of danger in mines charged with fire-damp.' The description indicates a great number of arrangements for indicating the presence of this gas : of this there are entire pages. Then, incidentally, quite at the end of the patent, we find the description of the lamp which I have quoted literally. This description speaks only of a single lamp ; the one described and represented in the figure. The patent certainly says : 'We might for lighting coal-mines make use of the lamp for which we have taken out a patent, the . . . .' (date omitted) ; but these are not the lamps which here come into question, since the inventor adds that these lamps are destined to be employed under the conditions which he had previously set forth, that is, to indicate the presence of fire-damp.

"Then comes the description of the lamp with a hydrothermic regulator not in combination with a metallic spiral, as M. Somzée affirms, but with a *carbon rod ;* and in the brief description of the lamp this word carbon recurs nine or ten times. The only paragraph where there is the question of a metallic spiral is the following : 'The arrangement short-circuiting a part of the current, and consequently reducing the temperature in the carbon, would enable us to utilise, in place of carbon, a metallic spiral, since it would always prevent the heat from increasing in a dangerous manner in the circuit of resistance and consequently this circuit would be preserved indefinitely. *Nevertheless, it is still better to keep to the use of a very dense and very pure carbon.*

"And it is from this description that M. Somzée concludes that *he only employs the hydrothermic regulator in combination with a metallic spiral.* Let M. Somzée kindly tell us what sort of lamp he intends to describe if that which he describes is not the one of which he calls himself the inventor.

"M. Somzée says further that I have been good enough to admit that he has been the first to claim the use of a carbon filament.

"This is totally inaccurate. But before proving it I must here make a remark : in my communication of June last I recapitulated the conditions which, according to M. Evrard, the Somzée lamp fulfilled. I did this without verifying if the quotations were correct ; and, in fact, I had no reason to suppose that they were otherwise. I have, therefore, twice employed the word filament, to which, however, I have attached importance only since M. Somzée takes his stand exclusively upon this mutilated and inaccurate quotation to establish all his demonstration. In his description M. Somzée *does not even once mention a filament of carbon ;* he speaks merely of *a rod of carbon*, and nothing else. And yet I was so far from recognising Somzée's paternity of this expression, that I cited various patents which claimed the use of a carbon analogous to that of M. Somzée.

"I might further cite the patent of Charles Weightman, September 2nd, 1878, which mentions as matters suitable for incandescence *threads or filaments of silk or cotton transformed into flexible carbon.* This third assertion of M. Somzée's is therefore not more accurate than the two foregoing.

"M. Somzée says, further, that in speaking of a filament the question can only be of a thread of the greatest tenuity. But I have just affirmed, and I again repeat, that *M. Somzée never mentions a filament, but a rod of carbon*, and if a filament signifies a thread of the greatest tenuity, a rod signifies an object of a relatively great thickness.

"And yet it is upon this single word filament, which has never been employed by M. Somzée, that all his so-called invention rests.

"It is repugnant to discuss in a journal for electricians questions whose meanness and futility are beneath the notice of men in earnest, but if I do not notice all the inaccuracies, and the lack of sincerity of the arguments advanced against me, my opponent will soon affirm that I approve of and admit them. I continue, therefore, this uninteresting review of the arguments opposed to me by M. Somzée.

"'For the exigencies of his cause,' says he, 'M. Picard omits to mention the precise indication which I give of a novel result mentioned in my patent, and this forgetfulness is marked so much the more clearly with the stamp of an evident intention, as this result itself must constitute an undeniable character of patentability in the eyes of M. Picard, the author of a remarkable treatise on patents for inventions.'

"M. Somzée is sufficiently acquainted with patent law to know that a result cannot be patented. It was, therefore, not my duty to cite this hypothetical result, foreign to an application for a patent, any more than to quote the infinity of arrangements described in the same patent for detecting the presence of fire-damp.

If I had to discuss the value of M. Somzée's patent under the law (Belgian) of 1854, I should have some very different things to say; but this is not at all the question which occupies us.

"Here is the indication so clear and precise which is to give to M. Somzée's invention that surprising, undeniable value which otherwise it would not have.

"'The apparatus which we have just described is readily portable, and *such a lamp would be equivalent to more than* 20 *candles* (in the citation made by M. Somzée it is said *about* 20 *candles*). It is very cheap, very simple, and certainly presents several essential qualties which would be precious for lighting coal mines.' And this is all. It is upon this description that M. Somzée depends to prove that he has invented the Edison lamp, and that the patent of 1879 of this latter is merely a vulgar imitation of the Somzée patent!

"We shall see below the description of this Edison patent, and we shall easily show that it has nothing in common with the so-called invention of M. Somzée.

"This result of a light of *more than* 20 *candles*, indicated by the inventor, has absolutely no value from the point of view of the patent; other glow lamps had already given a light greater than 20 candles, and very probably Weightman's lamp would not have given a less light. But all this is of no consequence, and this point, so important in the eyes of M. Somzée, falls to nothing, like the rest of his arguments.

"M. Somzée continues: 'There is one thing which M. Picard has not failed to reproduce, but, be it understood, with exaggeration, that is the width of the carbon *filament* (*sic*) figured in the sketch traced in the text of my patent.'

"This becomes real childishness; I have never considered the dimensions of the pieces figured in a patent design as able to have the least influence upon the value of the invention described. M. Somzée, on the contrary, has taken the trouble to measure the thickness of Edison's carbon, which he finds 2 millimetres in width and 1 millimetre in thickness. But then, what must be said concerning the so-called filament of M. Somzée, which in his description is called a rod, and the width of which in his drawing is 3 millimetres?

"Before proceeding to examine Edison's patent of 1879, which according to M. Somzée I have striven to leave out of the question, let us sum up what has been distinctly and unquestionably established.

"1. M. Somzée's hydrothermic regulator is the reproduction of Edison's hydrothermic regulator.

"2. The filament claimed by M. Somzée is a rod of carbon, very pure and very dense (moreover, slender rods of carbon, threads and filaments of carbon, were known and described before the date of the Somzée patent).

"3. The horse-shoe form of the carbon was known.

"4. The withdrawal of the carbon from all oxidation or deterioration whatever, forms the object of several patents anterior to that of M. Somzée,

"5. Feeding the space of the globe with a neutral gas was known and claimed before the invention of M. Somzée.

"There seems then to remain to the latter a rod of carbon slenderer at the middle than at the ends.

"As for the Edison patent of 1879 which I have intentionally omitted to discuss, it does not resemble the Somzée patent in anything. I have shown the striking analogies between the Somzée patent of 1879 and the Edison patent of 1878, and yet M. Somzée denies these analogies. Let us therefore see in what the two patents of 1879 resemble each other. We know the Somzée patent, we know also that of the whole description relating to the lamp M. Somzée abandons as having been described before him everything save a rod of carbon in the shape of a horse-shoe, the arch of which is not as thick as the extremities.

"Edison's patent is entitled, 'Improvements in electric lamps and in the method of manufacturing these lamps.'

"The inventor expresses himself as follows:—'The object of this invention is to produce electric lamps, emitting light by incandescence, which lamps must be of a nature such as to offer a great resistance so as to permit, in practice, the sub-division of the electric light. The invention consists of a body of carbon emitting light, which body takes the form of a thread or plate rolled up or arranged in such a manner as to offer a great resistance to the passage of the electric current, and at the same time present only a small surface whence radiation may take place. The invention consists also in arranging this burner of a great resistance in an almost perfect vacuum, so as to hinder the oxidation or deterioration of the conductor by the atmosphere . . . . The current is led into the globe in which the vacuum is formed by platinum wires sealed into the glass. The invention consists also in the method of preparing conductors of carbon having a great resistance so that they may be suitable for yielding light by incandescence, and in the method of securing a perfect contact between the metallic conductors or conducting wires and the carbon conductor.'

"By this simple statement, we see perfectly that Edison claims neither the incandescence of the carbon, nor the glass bulb, nor an inert gas, nor any of the other known arrangements for incandescence lamps. He knows that all this exists and has been claimed several times. But he describes (and this is the object of his patent) specific means for practically realising what his predecessors, including M. Somzée, have vaguely indicated without any positive notion, or at least in a manner so incomplete that the process could not be carried out by the aid of the description.

"Edison describes his different processes of preparing carbon filaments; he speaks at length on the means of producing them of the thickness of 0·175 thousandths of a millimetre and of a length exceeding 30 centimetres. All this is described in detail with the aid of figures. And in these claims he speaks of the *filament of carbon prepared as described*, and not of any rod of carbon whatever, as does M. Somzée.

"I shall not launch out at greater length into a discussion which must, to competent persons, appear puerile. Everyone understands the question sufficiently to appreciate the value and the good faith of the arguments produced. I will add only one word: in the numerous processes which Edison has had to sustain the competent men who attacked him have produced a very large number of patents as anticipations; but to my knowledge it has not entered the mind of anyone to mention as such M. Somzée's patent. It is true that M. Evrard has only recently discovered the inventor of the Edison lamp, and that prior to this surprising discovery all the world (save perhaps M. Somzée himself) was ignorant of this capital point of our national history.

"I request you, Mr. President, kindly to insert this letter in the next number of the *Bulletin des Electriciens*, and I present you with the expression of my most distinguished sentiments."

PACIFIC TELEGRAPH COMPANY.

THE Eastern Extension Company, in view of competition by the Pacific Telegraph Company, has thought it advisable to make a proposal to the Australasian Colonies by which they hope to tie the hands of these Governments, and thus prevent the realisation of any trans-Pacific cable scheme.

The acceptance by the Australasian Colonies of such a proposal as that put forward by the Eastern Extension Company would confirm this company's monopoly, as the granting of the subsidies asked for would render the subsidising of competing lines next to impossible.

According to a telegram from Melbourne, the Postmaster-General of Victoria stated that the Eastern Extension Telegraph Company had suggested, for communications between Australia and Great Britain, a tariff of 4s. per word instead of the present tariff of about 9s. 6d. per word. They were prepared to make this reduction on condition of the Governments granting a subsidy of £75,000 per annum. An alternative

proposal was made offering a rate of 2s. 6d. per word in exchange for a subsidy of £100,000 per annum.

The wisdom of this proposal is evident, and demonstrates a far-seeing policy on the part of the Eastern Telegraph Company and its allies, and displays a keen appreciation of the magnitude of the danger which threatens them.

Let us now consider the interests of the Governments and general public. As before mentioned the granting of the subsidies to the Eastern Extension Company means the confirming of the existing monopoly, and a dependence on only one line of communication.

The establishment of a Pacific cable presents many advantages, notably, the creation of another route which would be of immeasurable value in cases of complications with foreign powers. This line would also be the means of giving communication to certain Colonies at present beyond the telegraphic pale. It is probable that the subsidies before mentioned are large enough in amount to warrant the laying of a Pacific cable, and the competition resulting from the carrying out of this scheme would be almost certain to lower the rates to those proposed by the Eastern Extension Company.

That our view of the case is shared by many of the Government authorities, is evident from the following remarks made by the Postmaster-General in his reply to a deputation of the London Chamber of Commerce. In his speech the Postmaster-General said :—" . . . . In reference to Colonial telegraphs, it has been suggested that it would be desirable to subsidise them, so as to enable messages to be despatched at a cheaper rate. This is rather a new principle, and conflicts with the views expressed by another member of the deputation, that we had outlived the day of postal subsidies.

"The question no doubt deserves consideration, but the healthiest and most satisfactory mode of reducing telegraphic charges is by competition, and the Government have looked with extreme approbation upon any such development of telegraphic competition as might tend to reduce the rates. Any gentlemen who saw their way to push any schemes of that sort, would find the authorities of this country, as far as they could be so, most cordial sympathisers, and most willing co-operators in cheapening the rates for telegraphing."

These remarks received the approbation of the deputation.

We have been induced to bring this subject before our readers owing to its importance, and to the fact that several of the most influential Colonists have seriously taken the matter up.

Tramways and Electricity.—Mr. William Abbott, the well-known stockbroker, in a recent circular, says with reference to electric traction :—"The shares of tramway companies have for a long period been completely out of favour. This state of affairs is in marked contrast to the activity which existed some years ago, when the shares of tramway companies in large and small cities were greatly sought after as a sound and progressive investment. It is very probable that they will be sought after again, and that before very long. The change will doubtless be brought about by the introduction of electricity. It will be remembered at one time steam was thought to be the great motive power of the future as a substitute for horses, but steam is costly, and in many instances not practicable ; but from certain developments and demonstrations which have lately taken place it seems probable that electricity will before long be the motive power of the future for tramways. It certainly works wonderfully well on experimental lines—on the Isle of Wight pier, also at Brighton and Blackpool. More will be heard of this new motor presently, and when its merits are more fully demonstrated there will be a demand for the low-priced tramway shares, which cannot now pay satisfactory dividends owing to the heavy cost of working by horses. Those which are likely to benefit most are such companies as the Wolverhampton, Sunderland, Hull, Swansea, Imperial, and Birkenhead."

LIST OF INSTALLATIONS PUT UP BY THE GULCHER ELECTRIC LIGHT AND POWER COMPANY DURING 1886.

	Arcs.	Incandescents
Sir W. G. Armstrong & Co., Newcastle... ...	50	40
Hawks, Crawshay & Sons, Newcastle	19	40
Palmer's Shipbuilding Co., Newcastle	7	...
Co-operative Stores, Newcastle	4	102
St. Bede Chemical Works...	...	10
Lambert & Co., Swansea	...	...
Vivian & Co., Swansea	...	...
Vivian & Co., Swansea	...	30
Edinboro' Exhibition, Edinboro'...	64	70
W. D. Hart, Edinboro'	1	10
Alley & McLellan, Glasgow	...	...
P. & W. McLellan, Glasgow	8	...
Whitefriars Printing Co., London	2	...
Jackson & Co., London ... ... Diving Plant	...	...
Coalbrookdale Co., Engine Works	7	...
Coalbrookdale Co., Iron Works	10	...
Monks, Hall & Co., Warrington	4	15
Manchester Edison Co., Manchester	10	...
Jonas, Brook & Bros., Meltham	...	200
Jonas, Brook & Bros., Meltham	6	80
Jonas, Brook & Bros., Meltham	...	250
Fox & Sons, Dewsbury	3	...
Clarke, Chapman & Co., Gateshead	22	...
Army Clothing Depôt, Pimlico	...	1140
Kaipoi Woollen Factory, New Zealand	...	250
Ashburton Woollen Co., New Zealand	...	140
Press Office (Lyttelton), New Zealand	...	30
Canterbury Times Office, New Zealand... ...	...	30
Ross Gold Mining Co., New Zealand	6	100
Scott Bros., New Zealand	...	40
Lyttelton Harbour, New Zealand	14	...
Nowell & Co., Manchester...	6	18
Gartside & Co,, Manchester	8	100
Royal Aquarium Co., London	23	60
Cadbury Bros., Birmingham	8	70
Player Bros., Birmingham	3	20
Fowler, Lancaster & Co., Birmingham	1	...
British Association Meeting, Birmingham ...	27	470
Cattle Show, Birmingham	26	175
The World's Fair, Birmingham	20	...
Admiralty... ... ... 10 sets for torpedo boats	...	...
Admiralty, H.M.S. *Minotaur*	...	...
H. J. Rogers, Watford	6	...
W. Peacock, London	...	30
Oude and Rohilkund Railway Co.	6	...
Carruthers Bros., Luton...	6	15
Shropshire Volunteer Co., Shrewsbury... ...	4	30
Limerick Corporation	...	...
Crystal Palace Co., extension	20	...
Crystal Palace Co., grounds	22	...
Temperance Association, London	4	40
G. Smith & Co., London	...	...
Tir Pentwys Colliery Co., near Pontypool ...	1	40
T. Veasey & Co., London ... ...3 dynamos	...	...
J. West & Co., India	6	...
Hall & Co., India	...	90
Milner's Safe Company, Liverpool	12	10
Burnley Corporation, Burnley	22	60
Ynishir Colliery, Wales	...	60
Beanland & Co., Huddersfield	...	15
Liddell & Brierley, Huddersfield	...	15
Lawson, Phillips & Billing, Bristol	...	70
Waddington & Co., Sheffield	4	30
G. Belliss, Esq. (private house), Birmingham...	...	83
Walker Bros., Walsall	3	...
E. T. Wright & Sons, Wolverhampton	...	60
Williams, Son, & Wallington, London	8	15
Bellman & Ivey, London	...	32
Shannon & Co., Londonderry	2	15
C. H. Bradley, Huddersfield	2	30
Ridley, Eiles & Co., Newcastle	8	15
Food Exhibition, London	10	60
Pontypool Iron and Tin Plate Co., Pontypool...	10	40
Watkinson & Sons, Huddersfield	...	120
Birge, Spence & Co.	...	...

In addition to the above installations, which have been erected complete, the Gülcher Company has supplied a large number of dynamos for lighting, plating, and depositing, and also a considerable number of arc lamps.

Testing Dynamos.—A course of seven practical demonstrations in the testing of dynamos and motors is to be given by Professor Ayrton, F.R.S., in the dynamo rooms and laboratories of the City and Guilds of London Institute, Exhibition Road, S.W., during February and March, 1887.

THE SNOWSTORM AND THE WIRES.

THE greatest sufferers, as far as monetary loss is concerned, by the exceptionally severe storm of Sunday night are undoubtedly the railway and telephone companies and the Government Telegraph Department. At no period in the history of overhead wires has the devastation caused by snowstorms been so extensive as now. From every part of the country over which the storm raged comes the same story of broken wires and fallen posts. The snow which fell was of that character which most readily coheres, forming quickly large masses upon the wires and against the supports; and the weight of these masses, with the great force of the wind which prevailed superadded, proved far too great a strain for the comparatively fragile electrical conductors. The summary which we give of the most serious consequences to telegraph and telephone wires only faintly represents the vast extent of the destruction wrought by the hurricane. The cost involved by the repair of the damaged wires will not, we surmise, be learnt for some considerable time.

To begin with the Metropolis, the Post Office authorities made known on Monday that telegraphic communication was totally interrupted from London to the east, south-east, south, and south-west of England. There was partial interruption to the North of England, Scotland, and Ireland, with heavy delay, but the communication in the North of England, Scotland and Ireland was generally good. There was no delay to the Inner London local traffic. The Submarine Telegraph Company notified the total interruption of communication with the Continent. In consequence of this interruption the morning papers on Tuesday were without their usual supplies of Continental news. The messages received from America by the Commercial Cable Company were brought to town from Bristol by train. All telegraphic communication from London and the provinces to the Central and Southern parts of Europe by the ordinary routes was interrupted. Numerous messages from those countries were received by the lines of the Great Northern Telegraph Company, which company announced that it was prepared to receive outward messages at the higher rates, as prescribed by the International Telegraph Convention, if marked "*vid* Northern."

Throughout the city the wires were lying in all directions. Some of the telegraph supports, snapped off short, swayed in the wind high overhead: while in other places bunches of 30 separate telegraph wires lay broken in the roadway. In Cornhill, Cannon Street, Coleman Street and St. Paul's Churchyard, where the wires are especially thick, the damage done was exceptionally great.

With the railway companies the wholesale destruction of wires proved a very serious calamity. No signals could be transmitted, and all the trains were sent through by hand signals, the delay being very considerable. The North London, the South Eastern, and the London, Brighton and South Coast Companies were sufferers; but the London, Chatham and Dover Company was especially unfortunate. Nearly every telegraph pole on the suburban lines near the City was either broken or damaged in some way. One of this company's engines was engaged for three-and-a-half hours in clearing the line of obstructions in the shape of fallen telegraph posts and wires over a distance of less than three miles between Victoria and Clapham, and even after the most strenuous exertions it was only possible to keep open a single line. On Blackfriars Bridge every wire was down, the telegraph poles being snapped off short.

The police displayed common sense and alacrity in coiling the broken wires which fell in the streets round the nearest lamp-posts, thus lessening the danger from this source. No serious accident has occurred, so far as we have learnt, from falling or fallen wires, but some of the newspapers contain a statement that "several slight accidents occurred in the early morning" of Monday through the wires being down across the roads. The only incidents of which we have heard which can be conceived by the greatest stretch of the imagination to approach the character of accidents are the "narrow escapes" of a lady in New Bridge Street shortly after 11 o'clock on Sunday night, and of the daughter of a police inspector at King's Cross; but "narrow escapes" are not accidents. In the case of the inspector's daughter it is stated that the wires "caught her in the back," but the accounts do not suggest that the capture resulted in any, even the slightest, injury. The wires struck the umbrella of the lady in New Bridge Street, damaging it, but the lady herself was unhurt. A large telegraph post erected on the roof of the "Feathers," Waterloo Road, stretching to the "York Hotel," York Road, Lambeth, was split in two, and a number of pedestrians narrowly escaped being struck by the curling wires. The breaking of the wires in some districts seems to have been more rare than the breaking of the poles, the enormous amount of dead weight on the main lines having the effect of either dragging the latter from the roofs of houses or of snapping them off short, the wires breaking only where the stretch was of more than usual length. This occurred in High Street, Whitechapel, the wires and insulators coming down and lying across the roadway where the hay market is usually held. In the Mile End Road adjacent to White Horse Lane, in a court, the wires broke the staff short off in the centre, and the lines dangling from the housetops served to amuse the children to swing upon until the arrival of an *employé* of the telephone company. A similar break took place in Arbour Square, Commercial Road, the telegraph post broken off sliding by its weight to the centre, and then dangling across the road to the danger of vehicular traffic by reason of its shifting backwards and forwards as the wind played upon it. Hackney and Clapton, standing mostly on high ground, also suffered considerable damage. Five telegraph wires extending across Mare Street, close to the North London Railway Station, were blown down, and similar injury has occurred in other places, including the telegraph over the Fire Brigade Station in Pembury Road, where the post also was blown down. In Rotherhithe, Bermondsey, Walworth, and the adjoining districts there was scarcely a set of overhead wires intact, and in all the principal thoroughfares in those neighbourhoods wires were drooping across from one side of the road to the other so low that police officers were told off to warn people riding on the top of high vehicles of the dangers they incurred. Besides drooping wires, some hundreds which actually fell to the ground were cut by the police and secured where they could cause no injury. In some cases on the telegraph poles giving way the roofs of houses were uplifted and numberless chimney pots knocked over. Prior to the storm a telegraph standard stood on the roof of one of the houses in Montagu Place, Old Kent Road, but late on Sunday night it was blown down, together with the chimney stacks, and became entangled in the wires stretching across the road, to the alarm of the passengers below. In the neighbourhood of Clapham considerable damage was done to the telegraph wires and posts on the London and South-Western Railway, the wires being snapped asunder through the weight of the snow, and the supports blown down, causing great delay in the traffic. At Clapham Junction a very tall post was split asunder, the insulators and wires falling across the approach road, and breaking down part of the fence. Other poles near the station were also damaged, and the signal-box just outside the Junction had a narrow escape of becoming a total wreck, as one of the telegraph poles adjoining broke off short, and fell on to its roof, but fortunately little or no damage was done. In Battersea and adjacent districts also the havoc wrought on the telegraph wires was very great. The corrugated iron roof at the Gas Works at Nine Elms was forced in, and of 20 wires attached to a standard on the roof of the Royal Rifleman public-house only two were left intact. At King's Cross the wires were hanging in sheaves. In one case the whole section of strands of wire from one signal box was lying useless on the ground. Near Farringdon Station on Monday morning every third or fourth lamp-post had a broken wire tied round it, and in Farringdon Street, near the Viaduct, the broken wires hung in festoons across the broad thoroughfare. The snowstorm was severely felt in Westminster, considerable damage having been occasioned by the collapse of the telegraph wires. The wires extending from Sugg's factory in Vincent Street were damaged, and the post at the Artillery Arms, Rochester Row, was injured to such an extent as to stop telegraphic communication, whilst the post at the Wesminster Brewery Company's premises in Earl Street was also broken. On Monday morning the wires extending from the roof of 38, Marsham Street, gave way, and, coming into contact with the coping, caused the latter to fall with great violence. In Canning Town the snowstorm disarranged telegraphic communication in all directions, and hand signals were necessitated for the railway traffic. On the Walthamstow lines also hand signals had to be employed in consequence of the broken telegraph wires between Stratford and Broxbourne. Stratford, in fact, was cut off telegraphically from the whole of the country district, and though communication was maintained with London, few messages could be sent. The police-station wire was broken, the whole of the fire brigade wires were useless, and in only a few instances was there a complete wire running through Stratford. In the early hours of the morning a telegraph wire in Belsize Park Gardens gave way, and the wires at Golder's Green, providing communication between Hampstead, Hendon, and Edgware also broke down. On Tuesday morning an accident occurred that only by a miracle, as it were, did not result in a fatality. At about 2 o'clock a telegragh wire snapped, and the watchman in the service of Messrs. Lazarus, tailors, at the corner of Worship Street, Norton Folgate, at once proceeded to haul in the slack and attach it to a lamp-post adjacent. Whilst so engaged, about 10 feet of the coping of the roof of the Phœnix public-house came down with a tremendous crash, one end striking the hat-rim of the watchman, cutting it through, striking him on the shoulder, and then burying itself in the accumulated snow in the gutter. The snowstorm did considerable damage in Greenwich and Deptford, the telegraph wires on the South Eastern, London and Brighton, and London Chatham and Dover lines being pulled down in all directions, and private telephonic communication with the City and communication by telegraph being entirely suspended in consequence of disarranged and disconnected wires. At the bridge crossing the roadway at St. John's (South Eastern Railway) a telegraph post, fixed by iron clamps to the wall, was pulled by the weight of the snow on the wires down on to the railway, bringing with it about 12 feet of solid masonry and brickwork. On the large space of ground in Oscar Street, Deptford, known as "The Green," over which passes the telegraph of the North Kent and main South Eastern lines, the ground is strewn with broken wires, and along the line many posts have been pulled out of the perpendicular. A collision between two trains which occurred near New Beckenham station on the Mid-Kent railway on Monday was stated to be a consequence of the breakdown of telegraphic communication between Elmer's End and New Beckenham stations. By this accident one gentleman was somewhat severely injured.

On Monday morning, out of nearly 500 wires connecting places outside the metropolis, only six were left standing. There was one to Belfast, one to Edinburgh, one to Glasgow, one to Liverpool, one to Manchester, one to Birmingham, and one to Dublin. Later in the day a second wire was got through to Liver-

pool, and a second to Birmingham, and by means of the latter communication was opened with Bristol. The work of repairing the damage was undertaken without delay, and on Tuesday the number of overhead wires in use was increased from nine to 29, additional lines being opened to Glasgow, Liverpool, Manchester (three being secured to each city), Birmingham, Leeds, Cardiff, Derby, Southampton, Salisbury, Guildford, St. Albans, Uxbridge, and several other places of less importance. In the suburbs of London no fewer than 250 wires were broken; but no interruption whatever occurred to the wires carried through underground pipes over what may be described as the commercial area of London. The boundaries of this district can hardly be defined in general terms, for the reason that the system of underground pipes has been developed by a series of spurs running in different directions. For instance, on one side of the City the pipes have been laid as far as Bromley, on another side they reach Barnet, while in a third they extend to Uxbridge. Many intermediate places have to depend for telegraphic communication solely upon overhead wires, and it was these which suffered under the pressure of snow and wind on Sunday night. The Stock Exchange lost every single wire which it possessed, and most serious inconvenience was the result. The Submarine Telegraph Company was in an equally unfortunate position, and the services with France, Belgium and Holland were entirely suspended. As far as the officials of the Post Office have at present been able to ascertain, the greater part of the destruction has occurred within a radius of 100 miles from London. At Maidenhead the wreck is complete, every pole and wire having been thrown to the ground, while the line from London to Lowestoft has also been dismantled. Wires carried along high roads and railways have suffered alike disastrously, and iron posts broke as often as those of wood. North of Birmingham, and in Scotland and Ireland, the wires were not affected by the storm, and local communication is going on as usual. All sorts of expedients have been adopted by the authorities of the Telegraph Department with the object of minimising the effects of this wholesale derangement. Thus the service between London and Cardiff has been resumed *vid* Birmingham. Aid has been summoned from parts of the country where the violence of the storm was not experienced, and gangs of men were sent to assist those stationed in the southern and eastern districts. Application was also made to the War Office, and the staff engaged in the work of restoration was augmented not only by an increased number of Royal Engineers, but by members of the railway, field telegraph, and other corps in the Army. It is the practice of the Telegraph Department to keep in each district the name and addresses of competent men who can be called upon in emergencies to repair the wires, and these, too, are being set to work wherever their services can be secured.

On Monday—although it was Boxing Day—20,000 messages were received at the Central Telegraph Department, and by far the greater part of them had to be forwarded by rail, being made up into special parcels, and despatched by the ordinary trains. Over 6,000 messages passed between different parts of London, and owing to the immunity which the underground wires enjoyed in the general wreckage, they were not in any way delayed. The overhead wires which have been damaged in London are as a rule those of one or other of the telephone companies, and not of the Post Office, the underground system having in recent years been extended to such a degree that every main line in the metropolis, as also in the large provincial towns, is now carried in pipes laid below the street pavement.

At Croydon nearly all the telegraph wires succumbed either to the weight of the snow or the force of the wind, and telephonic communication between the fire brigade depôt in Katharine Street and the Brighton Road station was cut off. Some telegraph poles were blown across the railway between Mitcham Junction and Hackbridge.

At Woolwich communication on the South Eastern Railway was only kept open with great difficulty and danger, the company's telegraph and telephone wires being everywhere broken.

At Uxbridge it is stated that the telegraphic breakdown was the most serious that has happened since 1868, whilst the railway disorganisation resulting from it was probably unparalleled. The last train on Sunday night from Uxbridge for West Drayton Junction, on the Great Western Railway, soon after its arrival at the latter station during the storm was delayed there for the night by the fall of a network of wires, the engine driver and stoker narrowly escaping serious injury. The last up train on the main line was stopped at the same point, many of the telegraph posts between there and London having fallen with the wires across the railway, and there was consequently a deadlock. At daylight there were as many as 11 trains and three detached engines in or about the station. Telegraphic communication on the line was altogether stopped, and hand signalling had to be relied upon throughout the day. The telegraph poles had in many cases snapped off short, and more than a hundred were reported to be down between Paddington and Slough, exclusive of those on the branch lines, where the damage was also serious. West of Hounslow and north of Uxbridge, points where the underground wires terminate, telegraphic communication was in all cases interrupted, and in some instances entirely stopped, and a similar state of things prevailed with regard to the extensive main line of wires taking the route of the Grand Junction Canal from Paddington. Between Paddington and Didcot, it was ascertained on Tuesday, no fewer than 230 poles were blown down, and the wires thrown in tangled confusion on the railway lines and embankments.

All the telegraph wires for miles round Aldershot were brought down by the weight of the snow, and telegraph posts were broken or thrown from their erect positions. The wire could be seen in many parts of the white surface coiled like watch springs. Upwards of 700 wires in the military department alone were broken. The whole of the available men in the telegraph battalion of the Royal Engineers were busily engaged for several days finding out the breakages and endeavouring to restore communication. The mail due at the Aldershot post office on Monday at 3 o'clock in the afternoon did not arrive until 10. The newspaper train from London, due at nine minutes past seven in the morning did not arrive until eight, and Aldershot was completely isolated from the world as regards telegraphic communication. At the post office messages, including press messages, were lying from an early hour until after mid-day, and such senders as then called to inquire concerning them were informed that there was no certainty of the time that telegraph communication could be opened with the metropolis or any provincial town. Communication, however, was restored by eleven o'clock on Tuesday.

At Windsor the weight of the snow collected upon the wires, and the whirling gusts of wind broke many of them and brought down the poles here and there, thus destroying telegraphic communication between the Royal borough and the metropolis and elsewhere, and causing considerable inconvenience to the Court and residents, the post office clerks being unable to transmit or receive messages, while the railway officials were placed in the same predicament. On the Great Western Railway travellers between Paddington and Windsor suffered much discomfort on Sunday night and yesterday morning, in consequence of the block caused by the damaged telegraph poles and wires, the journey to and from the metropolis, which is usually very speedily accomplished, taking in some instances three or four hours.

The full force of the storm was experienced in the Thames and Medway valleys of the North Kent district. Between Chatham and Sittingbourne the whole of the Post Office telegraph-wires along the Dover main road, a distance of eight miles, were blown down and all communication stopped. The line consists of 25 separate wires, and the Royal Engineers engaged in repairing the damage, stated that it will take quite two months to restore the poles and wires. On Monday morning the Sappers of the Royal Engineers were engaged at Chatham and Rochester in clearing away the telegraph and telephone wires, which were lying about in a dangerous condition. At Chatham station, on the London Chatham and Dover Railway, two of the tallest signal-posts were blown down, and in falling, they broke the telegraph wires. All telegraphic communication between London and Chatham was completely stopped.

At Sheerness considerable damage was done to the telegraph wires, and all communication by this method was suspended. One of the posts of the special wire which connects Admiralty House with the official residence of the Prince of Leiningen, and with the Admiralty Department at Whitehall, was blown down in close proximity to Sheerness Dockyard church.

At Gravesend, about two o'clock on Sunday morning, more than a dozen telegraph poles on the South Eastern Railway were broken down. Some of the poles fell across the roadway and others on to the lines, but a gang of men quickly removed the obstacles. Telegraphic communication was suspended the entire day.

At Dover the damage to the telegraph wires was most extensive and disastrous, the town being entirely cut off from communication with any towns, except one or two within a radius of six or seven miles. There are three sets of wires from Dover—the General Post Office, the South-Eastern Railway, and the London and Chatham Railway, and all these suffered alike. The London and Chatham lost communication except as far as Faversham, and Deal and Folkestone were the eastern and western extremities of telegraphic communication on Monday morning; all telegrams received at the Post Office being sent by train to London and places at a distance. It seems that the storm was first felt the heaviest nearer London than the coast, as the communication with the Metropolis was lost early in the evening; then the ruptures gradually extended down the line, until at 10 o'clock Tunbridge failed. The last point was Ashford, communication with which town failed at midnight. Considerable inconvenience was experienced in Canterbury by the disorganisation of the railway traffic and the interruption of telegraphic communication with London and other parts; communication was only partially restored late on Monday.

In West Kent telegraph wires were broken, and the officials at Sevenoaks were unable to communicate with any of the stations on the line of railway which passes through the town. The Post Office wires were also broken, and Sevenoaks was shut out from communication with the rest of the world for the time being. Communication through the Post Office was restored to London on Tuesday, but the wires to outlying parishes remain blocked.

In the Dorking district of Surrey, it was ascertained late on Sunday evening that in many places telegraphic communication had broken down, and at daylight on Monday morning it was found that in all directions great damage had been done to the plant, many posts having been blown down by the gale, and the wires snapped, twisted, and broken.

At Guildford telegraphic communication was almost entirely destroyed. Of nine instruments at the post-office only one, a relief wire to London, could be worked, and at the railway-station the whole of the wires were disorganised, the only communication possible being from the station to the post-office.

The snowstorm proved very disastrous in the neighbourhood of

Reading in the stoppage of traffic and of all communications. Many of the South of England Telephone Company's wires were broken. The wires were curled round lamp-posts and railings. In one of the principal thoroughfares a gentleman became entangled in a falling wire, but was not injured. The entire telegraph service in the Reading centre and on the three railway systems broke down, and though the Post Office has some 30 telegraph instruments at Reading the office was completely isolated. It was the same with the railways, and the members of the staff were in perfect ignorance of the whereabouts of any of the trains, and on the Great Western line they could not even signal to the Western Junction, a mile distant. The North-Western train, due at Reading on Sunday night at 9·45, did not reach that town till four o'clock on Monday morning, owing to the blocking of the main line by the fall of the telegraph poles and wires. A goods train running between Reading and Newbury at an early hour on Monday morning encountered an obstruction at Alderaston, and it was found that some telegraph wires had become entangled around the funnel of the engine, the result being that the poles were dragged for some distance along the line. The engine-driver and stoker had a narrow escape. At Enborne Junction the poles and wires were found lying across the railway, and on the Didcot line the wires were lying across the metals near Compton. The postal wires which were carried across Northbrook Street—the principal thoroughfare in Newbury—were also broken, and the telephone line between the Sanitary Steam Laundry at Greenham and the Market Place also came to grief.

The damage done to the telegraph wires and posts on the Great Western Railway in the West Berks and North Hants district, and also those on the Didcot, Newbury, and Winchester line, as well as the postal telegraph lines along the main London and Bath road, was far in excess of that caused by the great snowstorm in 1881, and the town of Newbury was entirely cut off from telegraphic communication with other parts of the kingdom. On the Great Western Railway as many as 25 or 30 telegraph poles were found lying on the permanent way within a distance of three or four miles, and this was the condition of things met with along the line for a considerable distance. The road lines suffered equally as much, and altogether some hundreds of telegraph poles were down in this part of the country.

The district telegraph lines north of Aylesbury were broken, and communication was almost stopped.

In Oxford the telegraph wires suffered most severely. Posts were down and wires rendered temporarily useless for a distance of nearly 18 miles. The telephone wires in the city were largely affected, and in some instances were the means of causing the destruction of chimney stacks to which they were attached. Between Oxford and Birmingham the devastation was not nearly so great, the storm having evidently been nothing like so serious in that locality.

At Lymington telegraphic communication was interrupted in all directions.

Throughout the north of Hertfordshire and adjoining parts of Cambridgeshire and Essex the telegraph service was greatly interfered with. All telegraphic communications from the Royston telegraph office was cut off excepting with Cambridge, and the latter town, owing to the breaking of upwards of 50 wires, was effectually cut off from other places.

Telegraphic communication between Salisbury and other towns in the neighbourhood was completely severed, telegraph wires and poles having come to grief in all directions. The full severity of the storm was also felt at Yeovil, a little further west, and the damage to the telegraph plant was so great that it was anticipated that some days would elapse before the mischief could be repaired. One of the large telegraph posts in Vicarage Street, Yeovil, snapped off on Sunday night, and demolished a brick wall inside which it was standing. A thick stay ran over an adjoining house, and as this did not snap the heavy post was drawn towards the roof, and became embeded in the eaves supported by the broken structure. Devizes was completely isolated by Sunday night's storm. The telegraph wires were down, and the railway trains were much obstructed.

At Portsmouth the apparatus of the local telephone exchange sustained severe injury. Wires were blown down in all parts of the borough, while one iron standard was bent almost at right angles and a wooden pole was snapped off. In consequence of the severe havoc which was wrought, communication was completely interrupted, and some considerable expense must be incurred before the exchange can be put into working order. Fortunately, no casualties occurred through the falling of wires. The telegraph wires suffered no less severely, and within the town as well as without these were snapped off in various places, with the result that communication was entirely cut off. A few messages which were received before the breakdown had been ascertained were forwarded to their destination by train. The latter service was itself considerably delayed, owing to the line being strewn with fallen telegraph posts. For instance, three excursion trains from Portsmouth were on Boxing Day delayed for five hours at Barnham Junction owing to a block occasioned in the traffic by this means.

Never since the telegraph service has been in the hands of the Government has there been so great an interruption of communication in the Bristol district as that which was caused by the snowstorm of Sunday. For upwards of 24 hours no telegrams were dispatched or received from the Bristol office, and though the use of one wire was obtained on Monday evening to London, Cardiff, Liverpool, and the north, telegraphic communications with all places west of the city were interrupted. The train service, too, was greatly delayed by fallen telegraph poles and trees, as many as 50 being blown down across the line between Bristol and Bath. The Sunday evening train to Salisbury came into collision with a telegraph pole at Warminster, and one passenger was slightly injured. The train afterwards encountered so many telegraph poles that it was deemed unsafe to proceed, and the passengers were made comfortable for the night at Heytesbury Station, continuing their journey at daylight.

At Stratford-on-Avon the storm broke the telegraph wires, and communication was destroyed. The railway wires were also damaged, posts being blown down and the wires lying across the permanent way. In the Coventry district the storm destroyed telegraphic communication in every direction, but the wire communicating with London was restored before noon on Monday.

Telegraph wires were broken down in nearly all parts of the hill district of Merthyr Tydvil, communication with Cardiff only being maintained.

The snowstorm did considerable damage to the telegraph and telephone wires at Peterborough. On the Great Northern Railway there was no telegraphic communication with King's Cross from Sunday night up to Monday afternoon. The block system was consequently thrown completely out of gear. The nine minutes past one a.m. up-train, due at King's Cross at ten minutes to three, did not get in until five o'clock, having to stop at each signal box, and the guard said it was the roughest night he had experienced for years.

By ten o'clock on Sunday evening communication between Birmingham and London had entirely ceased, all the wires being down along the canals, roads, and railways. Communication with all western and northern districts was also severed, as well as with Scotland, Ireland, and the Continent. There was a total cessation of telegraphing from ten o'clock until about two o'clock on Monday morning, when communication between Birmingham and London was successfully established *viâ* Manchester.

The greatest inconvenience was experienced in Exeter, owing to the severance of telegraphic communication with London and other parts of England. Many miles of telegraph wire were wrecked, and after the last wire to London parted, between 7 and 8 o'clock on Sunday night, no message reached Exeter by telegraph from any place outside the northern border of the county until late in the week. Messages were received from Cornwall and North and South Devon without much delay, but above Exeter the whole system was deranged, and the engineers were overwhelmed by the vast amount of work before them. Some messages handed in to the telegraph authorities in various towns on Sunday and Monday came through by post on Tuesday. All outward messages were refused, unless the sender was prepared to agree to despatch by post or train.

The damage caused by the storm is greater in Somerset than was at first supposed. Reports come to hand from every direction of damage to property and great inconvenience through the interruption of telegraphic communication.

Telegraphic communication ceased between Norwich and London, and many of the telephone wires were carried away at Norwich. On Monday local telegraphic communication was suspended to a considerable extent, in addition to the interruption of all metropolitan communication. On Tuesday, however, the wires were again in operation between Norwich and Ipswich, Norwich and Lynn, Norwich and Great Yarmouth, and Norwich and Lowestoft.

Telegraphic communication from Luton, after having been entirely interrupted for two days, was restored on Tuesday night, but only by means of the railway wires.

Great inconvenience was felt by the people of Hastings in consequence of the rupture of telegraphic communication between this town and other places, but more particularly with London.

Telegraphic communication between London and Brighton was cut off, and was not restored until Wednesday.

Upon further investigation, it was found that the storm resulted in far greater damage to property in Sittingbourne and the surrounding district than was at first imagined. For several miles the telegraph posts, both up and down the London Road, were snapped off, and strands of wire are dangerously strewed about the road. Telegraphic communication with London was completely severed. The officials at the post-office, acting under instructions from headquarters, declined to accept messages, and it was quite uncertain up to Wednesday when telegraphic communication would be resumed. There has been no parallel to the present state of things in this respect since the telegraphs have been taken over by the department. A large chimney at the "Rose Inn," Sittingbourne, was pulled down on Tuesday morning and fell with a loud crash on to a large window of an adjoining house, smashing the glass and framework to atoms.

Telegraphic communication between England and the north of the Forth has been practically stopped since Saturday night. Ordinarily the Dundee Post Office has four direct wires to London, but on Monday and Tuesday they had been deprived of the use of these, and messages to London and for the Midland Counties were being sent to Edinburgh and Glasgow for re-transmission to their destination. A week at least, it was supposed, must elapse before the telegraph system would be again in good working order.

A correspondent of the *Daily News* writes:—"The task of unravelling and mending the wires will almost be as long as that of erecting new lines. The latter course would almost be preferable, as it is now proved that the posts, at least in suburban districts, are too slender for the weight of wire put upon them. The question might also be inquired into of whether the new wires ought not to be less tightly stretched, and allowed a larger 'dip.'"

REVIEW.

The Arithmetic of Electrical Measurements, with Numerous Examples fully worked. By W. R. P. HOBBS (Head Schoolmaster of the Naval Torpedo School, Portsmouth). London: Thomas Murby, 3, Ludgate Circus Buildings, E.C.

There is but little which calls for remark in this little book, as it is practically constructed on the same lines as other books of the kind which we have before noticed. At the commencement of each chapter we have a few examples fully worked out, and then a large number with the answers only given. The several chapters are as follows:—I. Joint Resistance of Divided Circuits. II. Division of Current in Branch Circuits. III. Strength of Current—Cells in Series. IV. Strength of Current—Cells Abreast. V. Strength of Current—Cells in Series and Abreast. VI. Strength of Current—Cells in Opposition. VII. Electromotive Force. VIII. Resistance. IX. Battery Power. X. Best Arrangement of Cells. XI. Resistance of Conductors. XII. Electric Lighting. XIII. Miscellaneous Exercises. The book is hardly of such an advanced character as the well-known one of Day, but it is calculated to thoroughly exercise the students who may be studying the particular subjects treated of. With reference to the questions on the grouping of cells, which are of such a stock character and which form excellent exercises, we must confess we never heard of any cases in which such systematic grouping has ever been practically resorted to. We notice in the book the usual mis-spelling of the name "Minotto," which is given as "Menotti;" "Thomson" also is spelt as "Thompson." Such is the perversity of human nature!

NOTES.

Temporary Lighting. — At the annual dramatic entertainment given by the scholars of the Middle Class Schools, Cowper Street, E.C., on the evenings of 20th, 21st, and 22nd inst., the stage was entirely lighted by the electric light. Woodhouse and Rawson incandescent lamps were used, and the current was derived from E.P.S. accumulators, which were recharged in the daytime from the Finsbury Technical College almost adjoining the schools. The installation was carried out by Mr. Oswald Haes, of Messrs. Woodhouse and Rawson.

A Wind Motor for Electric Lighting.—Information has been sent us regarding a wind motor, designed for use with an electric lighting plant, which has novel features. The power of the motor in an ordinary breeze is said to be about on a par with an ordinary windmill presenting the same surface to the wind. As the wind increases in force the speed and power of the motor increase in proportion, without any check, except by the work it performs; but the machinery driven by the motor runs at one uniform speed, however much the motor may vary in speed. The idea of the inventor was to make a motor that would drive a dynamo to charge accumulators, and do its work automatically, without requiring the presence of an attendant. The motor is left free to start whenever there is sufficient wind to drive it, and when it attains sufficient speed to drive the dynamo safely, the dynamo is started automatically, and not before. When started, the dynamo will run at one uniform speed under any increase in the pressure of wind, and consequent increase in the speed of the motor; but when the wind decreases in force, so that the motor will not drive the dynamo at a sufficient speed to charge the accumulators, the dynamo is stopped automatically, and the same mechanism will break the contact between the dynamo and the accumulators.

The Proposed Electric Lighting of Portsmouth Dockyard.—It is satisfactory to learn that there is every probability that this desirable improvement will shortly be authorised by the Lords of the Admiralty. Hitherto, the electric light has often been used on board men-of-war preparing for commission, in order to admit of workmen being employed at night, and it would undoubtedly be a great boon if the same facilities could be extended to the various workshops. Everybody having anything to do with the dockyard is strongly in favour of the various thoroughfares there being more adequately lighted than at present, it being considered that the darkness which exists in many places favours malicious attempts at damage. The improvement which the suggested innovation would entail was strikingly demonstrated last week, on the occasion of some theatricals on board the engineer training schoolship *Marlborough*. On either side of the road leading to the ship large lanterns were arranged at frequent intervals, but as a thick fog prevailed at the time they were rendered almost invisible, and the road must have remained as dark as Cerberus but for the forethought of the committee, who had had several electric arc lamps placed along the line of route. The latter proved a complete success, and as a matter of fact this part of the dockyard was rendered more safe for vehicular traffic at night than it had been during the day, when the thick mist also prevailed.

Electric Lighting at Portsmouth.—In connection with the Christmas show at Portsmouth, Messrs. Lancaster & Sons, and Messrs. Antill & Company—the pioneers of electric lighting in the borough, and still alone among the commercial community in enjoying its benefits—took occasion to introduce some alterations which were considered necessary with the view of improving their system. Hitherto the Jablochkoff mode has been in vogue at these establishments, and two dynamos were in use for the purpose of feeding the various lamps, which each possessed 400 C.P. The improvement consisted in the substitution of the Pilsen system, each arc lamp being now of 2,000 C.P. In order to make the system more attractive these firms (whose establishments are next door to each other) have introduced incandescent lights into their passages and smaller rooms, 42 lamps being utilised in this way. On "show night" the arc lamps shone out with great brilliancy and attracted large crowds, who remarked on the comparative paleness and feebleness of the adjoining gas lamps, which were indeed placed at a great disadvantage.

Lighting of Railway Trains.—The *Pall Mall Gazette* has elicited some interesting information from the secretaries of the different railway companies in London regarding the light used in suburban trains. Since 1882 the London and South Western Railway Company has spent £20,000 in purchasing gasworks and fitting trains with gas-light. The cost per lamp for gas is only ·326d. against ·625d. for oil. The Company recognises in electricity "the light of the future," but it is yet too expensive for lighting railway carriages. The London, Brighton, and South Coast Railway Company is making experiments with the view of improving the lighting of its carriages. At the beginning of the new year twelve trains will be selected for this purpose. Six will be lighted with oil under new conditions, and six by means of electricity. The resolution to try the latter experiment has been come to in consequence of the results got with a train running on the Crystal Palace and Croydon lines. It is said that oil costs per train £70 per annum, and the estimate for electricity is £100, but it is hoped that the actual cost will fall below that sum. The company proposes to attach the dynamo to the axle on the guards' van and with it to charge the accumulators, so that even with a long stoppage the light will be maintained.

"E.P.S." Accumulators.—During the last 50 days the E.P.S. Company has received and executed orders for accumulators sufficient to supply 5,150 16-candle power lamps, having a capacity of 3,390,000 watt-hours, or 4,543 H.P. hours. These are exclusive of orders for a large number of cells suitable for motive power and other purposes.

Electric Lighting in France.—An electric light installation is shortly to be fitted up at the yards of the arsenal at Cherbourg, in order to facilitate the construction of vessels. Plant has been supplied for the armoured coastguard vessel *Vengeur*.

Electric Lighting at Leamington.—The Leamington Town Council has accepted an offer from Mr. Arthur Chamberlain, of Birmingham, to light the town with incandescent electric light at a cost of from 20 to 30 per cent. more than gas. Mr. Chamberlain proposes to lay in a temporary installation for the purpose of illuminating the Parade and principal public buildings with electricity during the celebration of the Queen's Jubilee.

Town Lighting on the Continent.—The "Helios" Electric Lighting Company at Cologne has, it is reported, offered to light the town of Elberfeld by electricity—the company to make the installation at its own cost, with the exception of the house connections, and to remove the whole at the end of a year if the town is dissatisfied with the result. In the event of failure of the installation the company further promises to return to each householder three-fourths of the cost of connections and fittings. The cost of the proposed installation is estimated at £15,000.

Electric Lighting at the Brighton Pavilion.—Upwards of £5,000 have been spent in efforts to make the electric light a success in the Brighton Pavilion; but the insurance company having taken exception to the manner in which the apparatus was fixed, electric lighting was discontinued in the beginning of the present year. Since then a report has been obtained from Mr. Preece on the subject, and he advises further expenditure. The question is now under consideration.

Electric Lighting on the Continent.—The Municipality of Contich, near Antwerp, is about to grant a concession to the Société d'Exploitation de Force Motrice et d'Eclairage for a town installation. The streets will be lit with arc lamps, and up to the present time private installations to the extent of about 300 incandescents have been arranged. Two installations for the transmission of power have also been contracted for, one of 12 and the other of 300 horse-power. The financial arrangements are as follows:—Incandescent lamps, 4 centimes per lamp-hour from 8 to 10 candles, 7 centimes per lamp-hour from 16 to 20 candles, 12 centimes per lamp-hour from 40 to 50 candles. Arc lamps, 40 centimes per lamp from 500 to 1,500 candles, 50 to 55 centimes from 1,700 to 2,000 candles. The charges payable upon first installation are as follows:—Twenty francs per lamp for an installation of 1 to 5 lamps, 18 francs per lamp of 6 to 25 lamps, 16 francs per lamp of 26 to 50 lamps, 13 francs per lamp of 51 to 100 lamps.

Telegraphic Communication and the Fisheries of the Western Highlands.—A writer in the *Glasgow Herald* upon the subject of the West Coast of Scotland fisheries investigation, accounts for the decline of the fisheries in the isles of the West Coast about Canna, by the absence of adequate telegraphic communication. Fourteen miles of cable in short lengths, he says, would connect all these small isles, of great aggregate importance, with the telegraphic system of the country; and that they were not so connected long ago is part of the greatest grievance the crofters and fishermen of the West Coast suffer—the persistent neglect of the authorities, whose first duty is to link every portion of the kingdom in the chain that only their monopoly has prevented enterprise completing.

The Telegraph v. The Telephone.—Writing to the *Times* from Campden Hill, Mr. John W. Batten says:—"Whatever may be the shortcomings of the telephone companies in this country in the Postmaster-General's eyes and possibly in the public eye as well, they can at least claim that they are doing a far larger business than the postal telegraphs, and at a cost to the public of less than a tenth of the sum charged by that department. From the latest report of the Postmaster-General, Blue Book C. 4,862, p. 32, it appears that the total number of messages sent over the Post Office wires in the London postal area, 12 miles from the G.P.O., for the year ended March 31st, 1886, was 15,081,433, or a weekly average of 290,027, at an average cost per message of 8·09d. During the week ended December 18th, the United Telephone Company passed over its wires, within an area of five miles from the G.P.O., 439,696 messages, at an average cost per message of ·75d., being exactly three farthings per message."

The New Zealand Cable Subsidy.—The following telegram from the chairman of the Eastern Extension Company to Sir Julius Vogel explains the present position of affairs between the New Zealand Government and the Eastern Extension Telegraph Company:—"In view of the deadlock which had arisen between the company and the Government, and the serious public inconvenience resulting, the Agent-General suggested to the company to revert to the position occupied by both company and Government prior to Nov. 1, so that the New Zealand Parliament should have the opportunity of fully reviewing the whole question next session. The company agreed to accept this suggestion, believing that it will be viewed as an evidence of their desire to meet the convenience of the telegraphic public as far as possible, and believing also that the New Zealand Parliament will appreciate their motives for terminating. The Agent-General now informs us that your Government will approve his suggestion that the company should restore the *status quo ante* for the next six months upon the companies agreeing to lower the press rate to 3d. per word on a guarantee of the press that the press revenue will not suffer by that reduction. We accept this proposal on the understanding that you ensure the press guarantee. Immediately on receiving your acceptance of this arrangement orders will be sent to our agent, and the Governments and press will be notified accordingly." The *Colonies and India* states that the action of Sir Julius is not altogether approved by the neighbouring Colonies, since, by increasing the terminal charges of messages from 6d. to 4s. for 10 words, he has made an arrangement which altogether favours the New Zealand public as against persons sending messages from Australia. The rate now imposed by the Eastern Extension Company is 10s. for every 10 words sent by cable to or from New Zealand. The Australian public, however, have in addition to pay 4s. to the New Zealand Government for land charges, and Sir Julius, having regard only to the interests of New Zealand, has allowed this 4s. to be used towards the payment of the charge of 10s. imposed by the company. He, therefore, at the expense of the Australian public, enables the people of New Zealand to send messages at 6s. for 10 words, as against 14s. paid by the people of Australia. Annoyed at this action, it is reported that the Australian Colonies have made arrangements by which the rates collected on Australian messages will only cover the cost of transmission to the terminal station of the Eastern Extension Company, and that the receiver in New Zealand will have to pay any land charges that may be imposed by his Government.

Lecture on the Telephone.—Mr. A. R. Bennett, of the National Telephone Company, last week gave a lecture at Cockermouth on "The Telephone." Mr. Bennett had a very interesting story to tell, and his audience repaid him for the instruction and amusement he afforded them with a cordial vote of thanks. An exchange at Cockermouth is in contemplation.

Specific Inductive Capacity.—At a recent meeting of the Cambridge Philosophical Society, a new method of determining specific inductive capacity, was described by Mr. L. R. Wilberforce. It consisted in the comparison of the directive couples upon two spheroids, the one made of the dielectric to be investigated, and the other of some conducting material, when they were placed in a uniform electric field. Mr. Wilberforce further indicated certain theoretical considerations with regard to the eccentricities of the spheroids and their manner of suspension, and stated a general theorem relating to the mechanical effect due to such a field upon a body of any material or form.

Settle's Patent Electric Lamps.—Mr. Miles Settle, the well-known mining engineer, has devoted much time, money, and labour to the development of both stationary and portable lamps for mines, and, as the outcome of his efforts, he has introduced a lamp which appears, says *Industries*, to answer the requirements of a satisfactory fixed light, whilst at the same time making considerable progress towards the production of a portable safety lamp. The former of these consists of an incandescent lamp suspended in a thick glass of tumbler shape, beyond which is an outer glass of similar form and constitution. Between the two glasses is a space of about 1½ inch, filled in with water, or, if preferred, carbonic acid gas or any fluid exerting pressure. Above the incandescent lamp a metal float is so arranged as to be governed by the pressure of the water below, any addition to the water causing the float to rise, and any abstraction of water making it fall. The water is regulated by means of small taps. The float acts as a switch, the raising of which, in the manner indicated above, connects the electric current and effects the lighting of the lamp; its fall disconnects the current, and causes the light to go out. An important feature of the lamp is the extreme sensitiveness of the float, the addition or abstraction of a very small quantity of water sufficing to make it operate. The current is created by a dynamo, situated above or below ground, capable of lighting 40 incandescent lamps, and worked by a small engine running at high velocity. It is conveyed to the lamps by means of strongly insulated wires, which are connected in such a way as to fall in with the workings of the float already described. Each lamp gives a bright and steady light of 32 C.P., visible for a distance of more than a quarter of a mile. The lamp has also passed satisfactorily through most exhaustive and crucial experiments made to substantiate its claim to perfect safety. The working lamp is constructed on much the same principles. Safety is its leading characteristic, and, owing to the action of a spring catch, the lamp, if once extinguished, can only be rendered serviceable by being opened with a key, which would remain in the possession of responsible officials. With regard to its portability, however, the fact of its depending for the electric current upon insulated wires conducted from the dynamo, is a drawback which must militate against its general adoption, and which, perhaps, outweighs the advantages derivable from its lightness, the weight being only 1¼ lb.

The Grosvenor Gallery Installation.—"Farad," who states that he is employed at "one of the hotels on the circuit" writes, differing from statements which have appeared in our columns as to the successful working of the secondary generators at the Grosvenor Gallery. During the last month, he says, the lights have been out in local situations six or seven times.

The Plymouth Gas Company.—Complaints are generally rife at Plymouth regarding the quality of the gas supplied by the company, and as the contract between the latter and the corporation expires in the course of a few months, various members of the council are threatening that unless an improvement is effected in the meantime they will be prepared to support the introduction of the electric light.

Equipment of Laboratories.—A paper upon "The Use and Equipment of Engineering Laboratories" was read by Prof. Alex. B. W. Kennedy at the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 21st inst.

Lighting of the Paris Post Office.—The new General Post Office in Paris is being lit up by gas. The engineer, M. Guadet, says:—At the Post Office the light which is required is not that of large lamps at a distance. It is necessary that light should penetrate into thousands and thousands of pigeon-holes; there must, therefore, be numerous small lights. Arc lamps would be useless here; glow lamps alone would be of service. But 2,500 glow lamps represent considerable expense; and it would not be possible to set up the electric system without putting up gasfittings too, to serve in case of emergency; and as the electric light is now only making progress it would be injudicious to sink money in a system of transitory value.

Polarisation of Resistance Coils.—Mr. F. C. Van Dyck, writing in reply to an observation by Prof. Mendenhall in *Science*, says:—"With my rheostat I fail to obtain any 'reverse' current properly so called. The secondary current obtained by us is in the same sense, whichever sense is given to the primary, charging current; and the secondary current is not in the same sense in all the coils. This rheostat is constructed with brass mountings and German silver coils: hence I infer that the main cause, at least of secondary current, is unequal heating of the junctions of coils with mountings. Since we obtained galvanometer deflections of equal amount, as well as in the same sense, for both senses of primary current through the rheostat, we failed to observe any polarisation effect by difference. It may be that thermo-electric effects at junctions of copper conductors with brass terminals happened to mask the polarisation in this case, though we could not believe it probable. If my explanation of secondary current be correct as far as it goes, would it not be well to make rheostat coils and mountings of the same material?"

Thorpe's New Electric Light Switch.—In designing this switch, one of the principal features has been to put the whole of the work in the face, so that at any time a defect or alteration to wires can easily be effected. The spring has a direct action on the lever and has no tendency to pull it over on one side, as is the case with many now in the market, and the action is very quick in either direction. The switches are all arranged to take a fusible wire, and they can be made with either wood or porcelain covers, and owing to the simplicity of construction they can be made at a low price.

Electric Railway in Buda-Pesth.—Mention was made, a short time ago, of a project for the erection of an electrical railway in the Hungarian capital. Since then, *Industries* states, the undertaking has progressed a step further, and seems almost secured. On the initiative of the Board of Works, a commission inspected the proposed line, and reported favourably as regards the general scheme, provided the contractor conforms to certain stipulations regarding the approaches to the landing places on the Danube and to the bridges, which must in no way be interfered with. As regards the vested interests of private parties which might be affected by this line, the commission is of opinion that the contractor should come to terms without the aid of the Town Council; but the latter promises to further, as much as possible, this undertaking. The concession, which will be given by the Board of Works, has not yet been granted, but is shortly expected. The contractors will probably be Messrs. Lindheim & Co., of Vienna; Siemens & Halske, of Berlin; and Moriz Balázs, of Buda-Pesth.

Electric Tramways in Paris.—*Industries* states that an order has been received by Messrs. Decauville, of Petit Bourg, Paris, for several narrow-gauge tramcars, which are to be driven by a system of accumulators and electric motors.

Accumulators in America.—We may expect during the coming year to hear of something considerable being done in the States with accumulators. A correspondent writes :—"Since Mr. Vail left the American Bell Telephone Company a year ago, his movements have been wrapped in some mystery. The secret is now out. Mr. Vail has gone into the accumulator business with the determination to make of it a still greater concern than ever the telephone has been. He and his friends have acquired the exclusive rights in the States of the patents for accumulators of Faure, Volckmar, Sellon, Swan, and many others. He has himself visited Europe two or three times during the year, and on one occasion took back with him a party of 20 electricians who had been specially trained in the manufacture of the Faure and Sellon accumulators at Millwall, London. It is stated that Mr. C. A. Faure has been engaged as chief of the experimental and laboratory department, and that Mr. W. W. Griscom will be engineer of the new factory started by Mr. Vail at Newark."

Tenders.—The Bombay, Baroda and Central India Railway Company are advertising for tenders for the supply of telegraph materials amongst other things, of which particulars can be obtained of the secretary, 54, Finsbury Circus, London.

Incandescent Lamp Patents.—We have in type a lengthy letter from a correspondent in which he discusses the *pros* and *cons* of the incandescent lamp suit. As the matter of the appeal is *sub judice*, we cannot insert the communication until the decision of the court is given.

Volk's Railway again Damaged.—Mr. Volk's electric railway on Brighton beach once more suffered from the effects of rough weather, the snowstorm of Sunday rendering a portion of the line unworkable for a time. During Monday, however, the damage was repaired, and on Tuesday the cars were again running the whole length of the line.

Notes from Scandinavia.—A well-known American firm of electricians has offered the municipal authorities of Christiania to illuminate that city by electricity. There appears, however, little prospect of the offer being accepted, as should the authorities decide upon this mode of lighting preference would be given to a Norwegian firm. The city of Filipstad, in Sweden, is to be lighted with electricity by a Swedish firm. The price to be paid for each arc lamp of 1,200 normal candles is £7 10s. per annum. The price for the incandescent lamps has not yet been fixed. A Swedish engineer, Herr John Luth (partner in the firm of Herrs Luth and Rosén, electrical engineers of Stockholm), is at present engaged at Mr. Edison's office in America in preparing the plan for lighting the city of Stockholm by the electric light. Mr. Edison has placed drawings and materials at Herr Luth's disposal, and assists him in his task. During the last four years attempts have been made at Utö, near Stockholm, to manufacture carbons for incandescent lamps, with the result that a company has now been formed to continue the manufacture, the capital of which is £5,000. It is estimated that in Sweden alone a yearly sale may be effected amounting to £3,000, which would leave a profit of about £1,800. During 1885 the Swedish State telegraphs laid and put into communication with its lines 82 miles of telephone wire, at a cost of £4,000, being nearly the same sum as in 1884. At the end of the year the length of the telephone wires was 1,368 miles, with 1,255 apparatus, of which 57 were in telegraph or central stations and 1,198 with subscribers. The General Telephone Company of Stockholm has invited designs for an artistic tower for their reception wires at their central offices. From the report of the Stockholm Bell Telephone Company it appears that the number of subscribers at the end of 1885 was 1,800. The profits for the year amounted to £1,500, being 6½ per cent. interest on the share capital. It is not uncommon in the autumn that birds of passage by settling on telegraph wires cause the insulators to become loose and wires to fall to the ground. This occurred last October to a long line of wire in Denmark, the birds in question being swallows.

Efficiency of Double Belts.—Mr. J. Emmerson, writing to the *American Engineer*, in reference to a discussion upon this subject, says :—"No general consideration has been given to the best means of transmitting the power evolved by falling water to the work it is to do. The noise caused by the use of gears has had a tendency to produce the idea that there is a great loss in transmission through such, and much more than by the use of belts, while in fact the exact reverse is the case if gears of proper shaped teeth are used. I think Mr. Crowell rather overstates the gain by the use of the double belt, but that can only be determined by experiment. At the best, about one and three-fourths times is the allowance of gain, by the use of double belts, over that of the single ; but that is for the regular double belt, made of two thicknesses, cemented and laced or riveted, but it may be doubted whether a belt with rows of rivets will do as well as one without having a smooth surface. The double belt, as arranged by Mr. Crowell, is different, and seemingly more sensible, for it allows each to do its share, which can not be the case with the ordinary double belt, for on that the outside one must be much the toughest. Place two belts as shown by Mr. Crowell ; make a mark on the edge before starting, and it will be found that they do not remain in the same relative position a moment after being started, but the loss by friction and slip from the use of belts is a serious one under the most favourable conditions, while by the crossed quarter-turn and quarter-twist it is extravagant, in some cases as high as 30 per cent. of the whole power used."

Incandescent Lighting from Arc Circuits.—Mr. H. P. Browne, of Chicago, has recently patented a method for operating and protecting incandescent lights in multiple arc groups on arc light circuits. Each multiple arc group of incandescent lamps is provided with an additional branch wire, in which is included a fine wire or high-resistance helix and an electro-magnet, so that only a small fraction of the total current will pass through it. The armature lever of this electro-magnet operates to close a short circuit around the group when moved from its normal position by the increased attraction of the electro-magnet or its core. When all the lamps of the group are in use, the high resistance coil of the electro-magnet, which is in multiple arc with the lamps, only receives its normal amount of current, and the armature or switch-lever remains in its normal position. The moment, however, one of the lamps in the group is extinguished, the high resistance coil receives more than its share of current, thus energising the core and moving the armature lever to close the short circuit, thereby cutting out the remaining lamps.

NEW COMPANY REGISTERED.

Water Primary Battery Company, Limited.—Capital : £100,000 in £5 shares. Objects : To carry on the business of manfacturers and dealers in all kinds of machines, chemicals, and appliances for the production, transmission, and storage of electricity, and for its application and use for lighting, motive power, or other purposes. The company proposes to enter into an agreement with Paul Raoul de Faucheux D'Humy. Signatories (with one share each) : P. R. F. D'Humy, electrical engineer, 2, Carlton Mansions, Clapham Rise ; T. C. Allingham, 23, Rowan Road, Brook Green ; A. Balderson, 18, Carlton Square, New Cross ; A. W. Peckham, 9, Duke Street, Portland

Place; E. Sage, King's Road, Richmond; A. Ford, 22, Gray's Inn Road. The signatories are to nominate the first directors. Qualification: 100 shares. The members of the board will be entitled to a sum not exceeding £75 each, out of the profits remaining in each year after payment of 5 per cent. per annum dividend. Registered 23rd inst. by Valpy, Chaplin and Peckham, 19, Lincoln's Inn Fields.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Jarman Electrical Company, Limited (in liquidation).—An extraordinary meeting of the shareholders in this company was held on the 26th ult. at 6, Great Winchester Street, when the following resolution was passed:—"That in consideration of the Electric Locomotive and Power Company, Limited, relieving the Jarman Company from all liability in respect of a bill of exchange for £500, dated 13th April, 1886, and drawn upon and accepted by the Electric Locomotive and Power Company, Limited, and endorsed by Messrs. Barclay, Bevan & Co., and a bill of exchange for £1,500, dated 13th April, 1886, drawn upon and accepted by the same company, and endorsed by Richard Cory, and also in consideration of the sum of £108 to be paid by the Electric Locomotive and Power Company, Limited, to the liquidator of the Jarman Company, that the said liquidator be authorised to surrender to the Electric Locomotive and Power Company, Limited, for the benefit of that company, 200 of the 1,800 fully-paid shares in the Electric Locomotive and Power Company, Limited, held by him on behalf of the Jarman Company, and to cancel a bill of exchange for £1,108 9s. 9d., dated 13th April, 1886, drawn upon and accepted by the Electric Locomotive and Power Company, Limited, and to discharge the last-mentioned company from all claims thereon." This resolution was confirmed on the 13th December, and duly filed on the 21st December.

Sir Coutts Lindsay and Company, Limited.—The nominal capital of this company has been increased by the addition thereto of £100,000 in £1 shares, beyond the registered capital of £100,000, and a notification of the same was duly filed with the registered documents of the company on the 23rd December. This increase is in accordance with a resolution passed at a meeting of the company held on the 17th December.

United River Plate Telephone Company, Limited.—The registered office of this company is situate at 53, New Broad Street, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

Pilsen-Joel and General Electric Light Company, Limited.

THE fifth ordinary general meeting of the shareholders of this company was held at Cannon Street Hotel on Thursday, last week, Sir Rawson Rawson, K.C.M.G., C.B. (chairman), presiding.

The report was as follows:—"The directors beg to inform the shareholders that the resolution recently passed for a further reduction of the company's capital has been duly confirmed by the order of the court. The accounts and balance sheet embrace the period from June 30th, 1885, to June 30th, 1886, and the capital therefore appears as it stood on the latter date. The amount of calls in arrear was reduced during the year referred to by nearly £500, and the board have since felt it to be their duty to forfeit the shares of those still in default. The number so dealt with was 3,517 shares, leaving 24,483 partly paid up shares outstanding. The paid up capital of the company therefore at present stands at £30,828 15s., of which £30,603 15s. is represented by £1 5s. per share now credited on the 24,483 outstanding partly paid up shares, and £225 by the 100 fully paid up shares, now reduced to £2 5s. each. The directors, in submitting the present report and accounts, congratulate the shareholders that, during the period dealt with in the accounts (the first year's working at the new factory) a net profit of £1,111 7s. 8d. is realised. The company's business since June 30th, 1886, shows results equally favourable. The board have, subject to the sanction of the general meeting, declared a dividend on the present paid up capital of the company at the rate of 8d. per share on the partly paid up shares, the equivalent amount in respect of the fully paid up shares being 14d. per share. This payment would absord £821 18s. 8d., leaving a balance of £289 9s. to be carried forward."

Mr. Trentham having read the notice convening the meeting,

The Chairman, in moving the adoption of the report, said when they met on the last occasion, in the middle of 1885, they undertook at a time of difficulty to carry on the affairs of the company in such a manner that they should not, at all events, lose any of the remaining capital, and that they should keep the affairs of the company in such a condition that whenever the electric light was likely to come into general use by some Act of Parliament which would lead to street lighting, and, consequently, to the development of the use of arc lamps, which was their principal patent; and when the difficulties which had affected the question of incandescent lamps, and the contest between the Edison and Swan Company and the firm of Woodhouse and Rawson upon the question of the rights of the former—when all that was settled, there was reason to hope that electric lighting would take a decided development. This company had not, therefore, wasted its small funds in making attempts at development which had not succeeded up to the last year, and which they had no reason to hope would result more favourably; but they had kept down their expenses to the lowest, they had availed themselves of every occasion of making a profit, and almost unexpectedly to themselves they had been able to submit a balance sheet, showing an actual profit during the past year ending June last, which would enable the directors to offer a dividend to their shareholders. He had only to say, in addition to that, that their affairs had gone on quite as favourably since, and the prospects of the remaining half-year were quite favourable; so that they had reason to expect that this was the commencement of the resuscitation of the interests of the company, though, of course, the capital that was embarked in it at first had been absorbed—lost, in fact; and unless something very extensive occurred, of course they could not look forward to replacing that. But upon the reduced capital, which now stood at £25,000, they hoped to maintain a fair profit, that would enable the directors to offer a reasonable dividend, perhaps, in the future—even a large dividend—on the reduced capital; therefore he had confidence in asking them to accept and adopt the report and balance sheet for the last half-year.

Mr. Thomas Weyman seconded the motion, which was adopted unanimously.

The Chairman next moved that a dividend at the rate of 8d. per share on the partly paid up shares, and 1s. 2d. on the fully paid shares be sanctioned and approved. The shareholders, he said, would see they had shown themselves men of business, for they had not attempted to divide the whole of the small amount which they had for disposal, but had divided what they considered money fairly and actually earned, and left something that they might be able next year to divide at least an equal amount.

Mr. James Fyfe seconded the resolution, which was carried.

Mr. Hutton enquired if the £3,500 mentioned in the accounts was still invested in consols.

The Chairman replied that £4,500 was invested in consols.

Major Scriven was re-elected a director, and Messrs. Broom, Hays and Akers were re-appointed auditors, after which a vote of thanks was accorded the chairman, and the meeting terminated.

New Telephone Company, Limited.

THE second ordinary general meeting of the shareholders of this company was held at the offices of the company, 4, Great Winchester Street, E.C., on Saturday, 18th inst., Lord Thurlow, the chairman of the company, presiding.

The Chairman, in moving the adoption of the report, stated that the company had been successful at the commencement of its business in obtaining the license of the Postmaster-General. The telephone which the company supplied to the public was the invention of Dr. Silvanus P. Thompson. At first some little disappointment was experienced when it was found that the instrument did not prove so efficient for exchange work as had been anticipated. Since then improvements had been introduced into the instrument which rendered it thoroughly satisfactory, and he (the chairman) firmly believed that the company now possessed an instrument which was distinct and clear in its articulation, was a most valuable instrument for long distances, and was, in fact, second to none in the world. Although the company had only quite recently commenced selling telephones to the public, it was encouraging to be able to record that their sales were steadily increasing. Their telephones were now being freely sold in all the principal English and Scotch towns and provincial districts, also in Ireland and Wales, and testimonials proving their efficiency were daily coming in from customers. With regard to the financial position of the company, the chairman was happy to say that it was eminently sound. In reference to the future policy of the company, it was intended at the beginning of the new year to form a large and powerful company, and inasmuch as the company's patents were now known to be very valuable property, he felt convinced that there would be no difficulty in the formation of such a company. Moreover, the circumstances of the company's business rendered it necessary that a large company, which would be competent to further develop the business now established, should be formed without delay. In order to be successful on a large scale the company must open exchanges, and these could not be efficiently organised except by a powerful

company. Numerous applications from towns and cities in the United Kingdom had been received by the company with reference to the establishment of exchanges, and it would be the object of the new company to deal with these applications. In one of the most important installations undertaken by the company, there was some difficulty in overcoming the induction caused by the immediate proximity of an electric railway. On the line referred to a telephone in extensive use in this country was tried, and it was found that the induction was then enormously greater than when the company's instruments were working. The installation was, however, at last successfully and satisfactorily accomplished. The company's instruments were working perfectly in noisy factories in the West of England, where the circumstances were far from favourable for the good working of a telephone.

Dr. Thompson then addressed the meeting, and explained the improvements which had been made in the instrument. These improvements, he said, were, nearly all of them mechanical details, in developing which Mr. John S. Sellon had kindly rendered the most valuable assistance.

The adoption of the report was seconded by Sir James McGarel-Hogg, and unanimously agreed to, after which the retiring directors, Sir Daniel Cooper, Bart., and Mr. J. Irving Courtenay were re-elected.

The re-election of the auditors, Messrs. Deloitte, Dever, Griffiths and Co., having been also agreed to, a vote of thanks to the chairman and directors of the company concluded the business of the meeting.

Telephone Company of Austria, Limited.—The directors announce that coupon No. 4 of the Five per Cent. Debentures of the company, due January 1st, will be paid, less income tax, on and after that date by Messrs. Martin & Co., 68, Lombard Street, E.C.

West Coast of America Telegraph Company, Limited.—The coupons due on the 31st (to-day) on the debentures of this company will be paid by Messrs. Barclay, Bevan & Co.

United River Plate Telephone Company, Limited.—The letters of allotment for the whole issue of 34,000 shares in this company have been posted.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 24th were £3,120 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for last week amounted to £4,129.

NEW PATENTS—1886.

16810. "Galvanic elements." T. GOODMAN. (Communicated by C. Gassner.) Dated December 22.

16823. "Electrical batteries; making depolarising bodies to be used therein." E. BARBIER, M. LECLANCHE. Dated December 22.

16865. "Batteries for lighting, &c." L. R. DAVIES, M. SHEARER. Dated December 23.

16875. "Electric automatic signalling apparatus for railways, &c." W. P. THOMPSON. (Communicated by J. Sycinski and A. Berry.) Dated December 23.

16879. "Transmitting and receiving apparatus for printing telegraphs." W. S. STELJES. Dated December 23.

16901. "Electric safety lamps." F. WILKINSON. Dated December 24.

16908. "Effecting electric signals between the occupants of cages, hoists or lifts, and others." W. ARMSTRONG. Dated December 24.

16917. "Grapnels for submarine cables." A. JAMIESON. Dated December 24. (*Complete.*)

16919. "Anchor or apparatus for connecting any floating body to the ground when it is desired to maintain electrical communication between some station on shore and the floating body." G. H. LITTLE, P. HALE. Dated December 24.

16936. "Dynamo-electric and electro-dynamic machines." A. J. BOULT. (Communicated by F. L. Pope.) Dated December 24.

16942. "Converting electrical currents." J. D. F. ANDREWS. Dated December 24.

16984. "Engine telegraphs." G. SMITH. Dated December 24.

17002. "Electric arc lamp." N. MARISCHLER. Dated December 28.

17018. "Method of transmitting electric currents." M. H. SMITH. Dated December 29.

17050. "Making soles or socks for generating and applying magnetic electricity to the feet." T. COATES, H. W. CALL. Dated December 29.

17052. "Suspending overhead telegraph, telephone and like wires." A. E. HARRIS. Dated December 29.

17056. "Dynamo-electric machines." G. KAPP. Dated December 29.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

13551. "Improvements in apparatus for transporting cash, memoranda, or goods from one part to another part of a shop or warehouse, or for similar purposes." W. R. LAKE. (Communicated from abroad by The Kenney Electrical Cash Carrier Company, Incorporated, of America.) Dated November 7. 8d. The claims are 4 in number. Claim 2:—The railway forming a part of an electric circuit, and the conveying device or car combined with an actuating electromotor for the said car, and carriers and delivering and discharging devices whereby the receptacles are transferred to, and removed from, the said carriers, substantially as described.

14633. "Improvements in submarine and subterranean electric cables." A. M. CLARK. (Communicated from abroad by E. Flotron and F. B. A. R. De la Bastie, of France.) Dated November 28. 8d. Claims:—1. The improved construction of submarine and underground cable consisting in the application and combination of short lengths, sections, or pieces of toughened or other glass, porcelain, earthenware, or other similar insulating material made in the form of star-shaped discs or sections, or cylinders, either fluted or perforated, the same being so combined, arranged, and cemented together as to receive, enclose, insulate, and protect the conducting wires, the whole substantially as described and illustrated in the drawings. 2. The special application and employment in the manner described of toughened flint or other glass in the construction of all kinds of submarine or underground cables as specified.

14742. "An improved switch for electrical currents." R. M. BAILY and A. GRUNDY. Dated December 1. 8d. Claims:—1. In the construction of an electrical switch the combination of the discs or blocks, partly of insulating and partly of conducting material, mounted on a spindle or axis, and making and breaking contact with the surfaces of blocks, substantially in the manner set forth and described herein. 2. The combination and rotation of two or more of these parts, so as to form a bi-polar or single line switch as convenient or desired, substantially as described. 3. The combination of spring and catch, as described for holding the switch in the "on" position, with the method of releasing the same, and breaking the number of points required in the circuit with great rapidity and simultaneousness. 4. The improvements in switches for electrical currents, substantially as set forth and described.

15147. "Improvements in electric telephony." J. G. LORRAIN. Dated December 10. 11d. The inventor employs in the cases where condensers, or other so called statical instruments are employed, both as transmitters and receivers, two secondary generators, or their equivalents, one of which may be placed close to the transmitter and the other close to the receiver. By this means the high potential electricity at the transmitter may be converted into a comparatively low potential current before being passed along the line wire, and again by means of the secondary generator, or its equivalent, at the receiving station into high potential electricity so as to actuate the condenser, or other so called statical instrument used as a receiver. The claims are 5 in number.

1886.

7851. "Improvements in or relating to transmitters and receivers for mechanical telephones, and in the means or apparatus for manufacturing the same." J. FRASER. Dated June 11. 8d. Claims:—1. The manufacture and use of a receiver and transmitter for a mechanical telephone consisting of two flanged concavo-convex metal plates mounted and attached to supporting blocks by rods or pillars and having a perforated diaphragm inserted and fixed between the flanges of the said metal plates to which the line wire is attached by means of a pin or button, substantially as described and illustrated. 2. In a receiver and transmitter of a mechanical telephone and in combination with a perforated diaphragm the moulded or pressed casing or holder formed of two flanged concavo-convex metal plates bolted together with their concave surfaces facing each other and having the diaphragm inserted and fixed between them; and provided with suitable openings or orifices for the admission and insertion of the line wire and mouthpiece, substantially as described and illustrated. 3. The receiver and transmitter of a mechanical telephone as a whole constructed and arranged as described and illustrated.

9053. "An improved method of electrically reproducing articulate sounds." E. S. SPAULDING. Dated July 12. 8d. Consists in using a carbon transmitter as a receiver.

9403. "Improvements in galvanic batteries." A. J. BOULT. (Communicated from abroad by Dr. O. Lugo, of America.) Dated July 20. 4d. Claims:—1. A galvanic cell in which the negative portion is provided with a separate substance by which the elemental matter deposited in the action of the battery is removed, substantially as specified. 2. A galvanic cell in which the negative portion is provided with a separate substance by which the elemental matter deposited in the action of the battery is removed, such substance forming with the removed elemental matter a compound serving to replenish a portion of the battery.

10451. "Improvements in and relating to multiple telegraphy, and apparatus therefor." W. R. LAKE. (Communicated from abroad by A. M. A. Beale, of America.) Dated August 14. 8d. Has for its object the transmission of practically a large, and theoretically any, number of telegraphic messages in the same direction over a single conductor at the same time, and their reception separately and simultaneously, and consists of utilising the intervals occurring between the movements of the armatures of two or more electro-magnets. The claims are 9 in number.

10508. "An improved automatic electric liquid level indicator and controller." J. J. GHEGAN. Dated August 17. 8d. Consists chiefly in utilising magnetism so that a float located inside a tube connected with a steam boiler, or other liquid receptacle, operates a circuit closer located outside said tube, there being no mechanical or electrical connection between said float and said circuit closer. It also consists in devices for practically applying said float and circuit closer as a liquid level indicator and controller. The claims are 7 in number.

10630. "Improvements in electric fire alarms." R. M. SOMERS. Dated August 19. 6d. This invention relates to certain improvements in the mode of or means employed for operating electric fire alarms, when used for signalling purposes, after the glass has been broken and the alarm given, and has for its object the prevention of such apparatus or alarms being tampered with after the alarm has been given. The claims are 2 in number.

10644. "Improvements in electrodes for secondary batteries." A. MILLAR. Dated August 20. 4d. Claim:—The making of electrodes for secondary batteries, by combining together a number of strips of metal, which strips are either singly or in sets of two, three, or more, enveloped with a fibrous and somewhat elastic material.

10824. "Improvements in the construction of electrical batteries, and in the method of, and means, materials, and appliances for, working the same." J. T. ARMSTRONG. Dated August 24. 8d. The object of the invention is to effect improvements in the construction, arrangements, and working of ordinary electrical batteries, as well as in addition to, and in further development of certain improvements for which the inventor obtained letters patent, dated 17th February, 1885, No. 2,165, and 5th June, 1885, No. 6,878. The claims are 10 in number.

11054. "Improvements in apparatus for making and breaking electrical circuits." A. THOMPSON and R. O. RITCHIE. Dated August 31. 8d. In the place of the usual arrangement of rigid castings, by means of which the circuit is completed or broken, as required, in apparatus of this kind as now made. The inventors employ a number of rolled, or malleable, thin, flexible, metallic plates.

CORRESPONDENCE.

Electric Light v. Paraffin.

Your remarks on this subject hold the balance so fairly between the two sources of light discussed, that I feel confident you will permit me to point out that in no sense is the use of paraffin or petroleum in the lamp to which you specially referred, insecure or dangerous. Its construction, as Mr. Boverton Redwood has stated, absolutely prevents the possibility of explosion, with whatever oil it may be used, and however hot that oil may be. And its combustion arrangements are sufficient to permit of its burning a mineral oil of which the specific gravity and the flashing point (270° F.), while it renders it useless for other lamps, make it as safe for practical purposes as vegetable oil. There is no possible gain to the prospects of electric lighting in minimising the position of other sources of light. I have not scrupled to state freely, what it would be difficult to deny, that when electric light can be made as certain and as convenient as oil or gas, it will be a far preferable source of light for those people who can afford its cost; and when it can compete in price, it will wipe other sources of light off the face of the earth. But my experience hitherto, which has been in respect to primary batteries somewhat extensive and somewhat costly, has led me to much the same opinion as that which you express. It has been my duty in the course of business to examine anxiously a large number of the batteries which you have from time to time reviewed, in the same way as for twenty years it has been the misfortune of those with whom I act to examine some hundreds of petroleum lamps submitted for their consideration. And in just the same way as my partners had to wait twenty years, and endure the succession of hopes and disappointments which the ingenuity of inventors so well contrives, before they found the first petroleum lamp to which they felt justified in committing themselves, those interested in electric light will have to wait the lapse of time to bring about the reliable glow lamp and the suitable battery. When the time comes, I shall rejoice, and hope to profit by the occasion. In the meantime I watch with greater interest the application of electric lighting to those special purposes for which it is actually and immediately suited than I do the premature and fruitless attempts to force on to it a duty for which it is absolutely unready.

Wolf Defries.

Why Burn Oil?

Your correspondent, "Atom," appears to have been misled by the statement contained in the advertisement referred to, to the effect that chromic acid yields an oxidising solution "*twenty times as strong* as bichromate of potash."

Without questioning the advisability for trade purposes of making such a statement as this, which on the face of it appears very taking, and which, doubtless, has led others besides "Atom" to suppose that chromic acid is twenty times as *effective* as bichromate for battery purposes, I may, perhaps, be allowed to point out what is the real comparative value.

Taking, first of all, the bichromate battery, and writing the simple chemical formula for its reactive, we have:—

$$\left.\begin{array}{l} K_2 Cr_2 O_7 + 4 H_2 SO_4 = 2 (K Cr 2 SO_4) + 4 H_2O + 3 O \\ \text{and } 3 Zn + 3 H_2 SO_4 = 3 Zn SO_4 + 3 H_2 \end{array}\right\} 3 H_2 O$$

from which we see that the equivalent of bichromate plus 4 equivalents of acid, yield 3 equivalents of oxygen to combine with the 3 equivalents of hydrogen liberated by the action of a similar number of equivalents of zinc and acid.

For the chromic acid battery, we may write in its simplest form, and neglecting the action of the water in which it is soluble:—

$$\left.\begin{array}{l} 2 Cr O_3 = Cr_2 O_3 + O_3 \\ \text{and } \quad 3 Zn + 3 H_2 SO_4 = 3 Zn SO_4 + 3 H_2 \end{array}\right\} 3 H_2 O$$

From this we see that it requires 2 equivalents of chromic acid to account for the hydrogen liberated by the action of 3 equivalents of zinc and acid. Now taking the equivalent weights, we have for 1 equivalent of bichromate 295, and for 2 of chromic acid 201, or very nearly 3 to 2.

These, then, are the theoretical weights required to produce equal quantities of electricity; in other words, 3 lbs. of bichromate are equal to 2 lbs. of chromic acid.

"Atom" may now try the experiment of making up two solutions in these proportions, and ascertaining whether the practical result in any way corresponds with the theoretical value.

It must, however, be noted in the question of the relative cost, that whereas 1 equivalent of bichromate requires 4 of sulphuric acid to produce the reaction in the battery, the chromic acid does not require any, and there is therefore a saving in acid, though the conductivity of the solution would probably be improved by adding a little. The acid required for the zinc is, of course, the same in each case.

What I have now said will not, I think, be confounded with the comparative *strength* of the solutions. The solubility of chromic acid is much greater than that of bichromate, though whether it is twenty times as great I am not prepared to say; but probably this is what is meant by the statement in the advertisement.

It follows, therefore, that a given quantity of water may be made much stronger as a depolariser by using the more soluble chromic acid; but the commercial and electrical value of this substance, as compared with bichromate, will remain as pointed out above.

Acid.